ENERGY MANAGEMENT POLICY - GUIDELINES FOR ENERGY INTENSIVE INDUSTRY OF INDIA

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BEE
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Bureau of Energy Efficiency
Ministry of Power, Government of India

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Preface

The industrial sector in India is a major energy user, accounting for about 48% of commercial energy consumption. Also, the Indian industry is highly energy intensive and provides considerable scope of improvement in energy efficiency since it is well below that of other industrialized countries. There are wide variations in energy consumption among different units within the same industry sector using comparable technology. Energy saving potential in the industrial sector as a whole is estimated to be close to 25 percent. Despite the fact that most of the energy saving projects are financially viable for their investments, only a small fraction is actually tapped. However, there are few units in each of these industrial sectors, who have taken steps to reduce their specific energy consumption and are very close to the best in the world.

Recognizing the importance and benefits of energy efficiency, the Government of India has enacted the Energy Conservation Act, 2001, which has come into force from 1 March 2002. Under the provisions of Act, Bureau of Energy Efficiency (BEE) has been established by merging the erstwhile Energy Management Centre of Ministry of Power. The Bureau would be responsible for spearheading the improvement of energy efficiency of the economy through various regulatory and promotional instruments. The mission of Bureau is to institutionalize energy efficiency services, promote energy efficiency delivery mechanisms and provide leadership to improvement of energy efficiency in all sectors of the economy.

As one of the initiative in this direction, the services of The Energy Resource Research Institute (TERI) were retained by the Bureau to carry out a study on "Energy management policy- guidelines for energy intensive industry of India". A survey was carried out in six selected energy intensive industrial sectors through a questionnaire and field visits were organised in two industries in each of these sectors to know the present energy management policy and initiatives in these industries. This information was analysed and discussed with all stakeholders like industry, their associations and experts in a workshop held in

March 2003 in Delhi. As outcome of this study, Guidelines on energy management policy for energy intensive industries in general and six sectors are provided in this report. Need of energy management policy as an instrument to conserve energy, energy policy contents and model energy management structure in a medium to large energy intensive industry are also provided.

The Government of Japan under its Green Aid Plan (GAP) project also agreed to support the project under bilateral cooperation. It is heartening to note that during the course of this study, help was provided by various Japanese organizations, namely, METI, JETRO, NEDO, JODC, AOTS and ECCJ, who supported the project whole heartedly. The Japan External Trade Organization (JETRO) supported the study mission of 5 top management executives from Indian Cement and Pulp &Paper industry to Japan, The New Energy and Industrial Technology Development Organization (NEDO) and the Association for Overseas Technical Scholarship (AOTS) supported the mission to Japan for the senior managers from aluminium, cement, pulp& paper, steel, petrochemicals and textile plants in order to provide them an opportunity to interact with Japanese industries, who have adopted the small group activities and have successfully implemented the energy management policies. The New Energy and Industrial Technology Development Organization (NEDO) and Japan Overseas Development Corporation (JODC), provided the services of one Japanese Expert, Mr. Yoshiharu Ikeuchi, who provided the input on Japanese experience in the field of energy management

It is hoped that the report would be useful to the all energy intensive industries, research organizations, Government departments and to all those who are connected directly or indirectly with the energy efficiency aspects in the country.

The support and cooperation received from Japanese organizations and their experts, TERI, industrial units, industry associations and other organizations/departments is highly appreciated and gratefully acknowledged.

Shashi Shekhar

New Delhi
June, 2003

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Director General
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The support and cooperation received from various plants and industry associations is highly appreciated and gratefully acknowledged. The names of such plants and associations are mentioned here under.

1. Hindalco Industries Ltd.,Renukoot,
2. Indian Aluminium Ltd., Hirakund,
3. Chettinad Cements Corporation Ltd., Karur,
4. Madras Cements Ltd., Ariyalur,
5. The India Cements Ltd., Ariyalur,
6. Sriram Fertilizers and Chemicals, Kota,
7. Zuari Industries Ltd., Goa,
8. Reliance Industries Ltd., Patalganga,
9. Reliance Industries Ltd., Hazira,
10. Ballarpur Industries Ltd., Yamunanagar,
11. Star Paper Mills Ltd., Saharanpur,
12. Tata Iron and Steel Company, Jamshedpur,
13. Jindal Steel and Power Ltd., Raigarh

14. Aluminium Association of India (AAI),
15. Fertilizer Association of India (FAI),
16. Indian Agro and Recycled Paper Mills Association (IARPMA),
17. Indian Paper Makers Association (IPMA)
18. Steel Authority of India Ltd. (SAIL).
19. Cement Manufacturers Association (CMA)

1

Introduction

The 'Energy Conservation Act 2001 ' of Government of India envisages quantum savings (at least 10%) in the use of energy by all sectors of economy. The Industrial sector is one of the biggest consumers of energy in India. Over the years due to the practices of licences and quotas for production and a market which was considerably hedged from foreign competition, production had been emphasised upon even at the cost of efficiency. With the opening of economy and considerable increase in both domestic and foreign competition in the market, the industrial sector had to take steps to cut down costs mainly through better technology and efficiency of resources employed. This fact is apparent from the efforts made by the progressive sectors of the industry through more and more stress for implementing energy conservation and management activities.

Energy management is the collective term for all the systematic practices to *minimise* and *control* both the *quantity* and *cost* of energy used in providing a service, while also improving environmental outcomes and the level of service. The practices include:

- Minimising energy wastage
- Optimising energy efficiency with suitable technology
- Using the most appropriate energy sources (e.g. electricity, fossil fuels, renewables), with due regard to the environmental benefits
- Buying energy at the most economical price
- Modifying operations, wherever possible, to make the best use of energy price structures
- Involving, training and raising awareness of staff
- Continuous monitoring to ensure that energy use remains within predetermined limits.

Having been brought into the focus of the industries, energy management needs to be given a boost by way of giving inputs to the industrial sector, especially the most energy intensive sectors, as to how to implement the best energy management practices. This can be done by mutual sharing of experiences by the various players of a segment of industry and across different segments. With this rationale the study titled 'Energy Management Policy-Guidelines for the Energy Intensive sector of India' was sponsored by Bureau of Energy Efficiency, Ministry of Power, Government of India, and is conducted by The Energy and Resources Institute (TERI).

The idea of the project was conceived by the erstwhile Energy Management Centre (now Bureau of Energy Efficiency), while participating in the Japan International Cooperation Agencies' (JICA) sponsored project programme on 'Energy Conservation' at Kyshu International Centre (KIC), Japan, under the leadership of Mr N Shinkawa. The project was later on supported by the Green Aid Plan (GAP) project of Government of Japan under which the services of one Japanese expert, Mr Yoshiharu Ikeuchi, from the Japan Overseas Development Corporation (JODC) was provided to utilize the Japanese experience in the field of energy management, particularly the energy management structure and the Small Group Activities on energy conservation.

Under the GAP project, the Japan External Trade Organization (JETRO) sponsored Study Mission of 5 top management executives from Japan Cement and Pulp & Paper industry in order to provide them an opportunity to interact with Japanese industry, who have successfully implemented energy management policies and have established good energy management system.

The New Energy and Industrial Technology Development Organization (NEDO) and the Association for Overseas Technical Scholarship (AOTS) also together arranged a training-cum-study mission of the senior managers from aluminium, cement, pulp & paper, steel, petrochemical and textile plants. These industrial personnel were exposed to the Japanese energy management system and visits were arranged to the progressive Japanese industries, which have adopted the Small Group Activities and have implemented successful energy management programmes.

Six most energy intensive sectors of the industry were chosen for the study. These are

1) Aluminium
2) Cement
3) Fertilisers

4) Petrochemicals
5) Pulp & Paper and
6) Steel.

In order to grasp the current state of the energy management in these six sectors, a questionnaire survey was conducted. The survey was designed to get the quantitative details of the energy consumption as well as qualitative details of how energy management is undertaken in the plants, and what are the perceptions of the plants with respect to policy for energy management. The questionnaire survey was followed up by field visits to two plants of each sector for discussions with senior plant personnel.

The data from the questionnaire survey and the field visits were consolidated on sectoral basis and sector specific reports were prepared. These are given as chapters 3 to 8 in this report.

A workshop was also organised on March 1, 2003 with participation from industries, their associations and experts from these industrial sectors.

Based on the deliberations at this workshop and the questionnaire and field surveys, the general guidelines on formulation and declaration of energy management policy have been evolved. A model organisation chart for energy management structure applicable to all energy intensive industries has also been proposed. These are given in Chapter 2.

2

Guidelines on Energy Management Policy

2.1 Background

India's energy intensity per unit of GDP is higher by 3.7 times that of Japan, 1.4 times that of Asia and 1.5 times that of USA, indicating very high energy wastage, and thus potential of substantial energy saving. The increasing liberalization of global trade through WTO and growing competition have made productivity improvement and energy cost reduction as the most important benchmarks for economic success.

This calls for concerted efforts by industry to reduce energy intensity for their products. India's projected economic growth is slated at 7.4 percent in the period 1997-2012 (Planning Commission). This would necessitate commensurate growth of commercial energy resources, most of which is expected to be from fossil fuels and electricity. To bridge peak power shortages (13 to 15%) and average shortages (8 to 10%), India would require fresh capacity addition of nearly 100000 MW (assessed by Central Electricity Authority), more than 75% of which is likely to be coal based. This would require an investment of the order of Rs 800,000 crores. This poses a great challenge to a developing country like India. India needs a paradigm shift in approach to overall energy policy issues – a shift from supply domination to an operational efficiency improvement of existing power generating stations, T&D losses reduction, and most importantly the end use efficiency improvements.

In view of the above, integrated resource planning and demand side management (DSM) including active promotion of efficiency in end uses of energy should evidently constitute our long-term energy strategy. The policy goals and concepts will have to be shifted from energy conservation to energy efficiency and from energy inputs to the effectiveness of energy use and energy services for all sectors of economy.

The industry sector, a major consumer of energy, has significant potential to improve its end-use energy efficiency resulting in reduced energy consumption and cost minimisation. This is more so crucial for the energy intensive sectors like, cement, fertilizer, and iron & steel, etc.

2.2 Energy policy statement

Having a well-defined energy policy at corporate level, is the first significant step towards achieving long-term goals of energy management in the industry. A corporate level energy policy would give objectivity, purpose and motivation to all the efforts made throughout the organisation in improving energy efficiency and managing best end-use of energy. Although several leading Indian companies nave a focus on energy efficiency and energy management aspects, this commitment has not been formalised in all cases through a company-wide energy management policy.

If commitment to managing energy is left to operate on an unofficial or adhoc basis, it can be derailed or its impact lessened by changes in personnel, whether among top managers or co-ordinators. Where commitment is informal, the loss of a key decision maker at any of these levels can undermine energy management activities. Additionally, unless commitment is formally endorsed, there is also a danger that other priorities will crowd out the attention given to energy management whether in terms of managerial time or allocation of staff and resources. Furthermore, unless responsibilities and accountability for energy consumption are clearly written down and routinely distributed to all relevant employees, they cannot easily be included in staff performance evaluations.

It is a well-established fact that a formal written energy policy acts both as:

- a public expression of an organisation's commitment to energy management
- a working document to guide energy management practices and provides continuity

These two aims suggest that the policy should be published in two parts. Part 1, comprising of an expression of commitment and summary of general principles, for publication and dissemination. Part 2, the detailed operating policy containing commercially sensitive information and procedures, for internal circulation and operationalisation. A sample of energy policy contents[a] is given below.

2.1.1 Sample energy policy contents

Part 1

1. Declaration of top management commitment to, and senior and middle management's involvement in, energy management
2. Statement of policy
3. Statement of objectives, separated into short and long-term goals

Part 2

1. An action plan specifying work programme over a time frame
2. Budgeted resource requirements including staffing complement, investment and training needs necessary to achieve the objectives of the program
3. Assigned responsibility and accountability for actions outlined, specifying individuals by name and position
4. Description of energy management cell's responsibility, structure, membership and reporting mechanisms
5. Appoint cell representative for each department and specification of internal and external lines of communication
6. Statement of review procedure, defining milestones and mechanisms for assessing overall progress and value for money as well as appraising the performance of individual members of staff.

The language of the policy statement should be very succinct. For example:

- The declaration of commitment might say:
  "As part of our environment strategy, this organisation is committed to responsible energy management and will practice energy efficiency throughout all of our facilities, plant and equipment, wherever it is cost effective to do so"
- The policy statement might be:
  "The policy of this organisation is to control energy consumption in order to:
  - Avoid unnecessary expenditure

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[a] These sample energy policy contents have been taken from Aspects of Energy Management, General Information Report 12, BRECSU, 1998

  - Improve cost-effectiveness, productivity and working conditions
  - Reduce greenhouse gas emissions and protect the environment
- Some goals might be stated as:
  - To buy fuels at the most economically advantageous cost
  - To utilise fuels as efficiently as is practicable
  - To reduce the amount of pollution, particularly CO2 emissions caused by our energy consumption
  - And, to reduce, wherever possible, our dependence on fossil fuels through the use of renewable energy and recoverable energy in the plant
- Finally, some immediate objectives might be identified, such as:
  - To gain control over energy consumption by reviewing and improving purchasing, operating, motivation and training practices
  - To invest in a program of energy saving measures which will maximize returns on investment in order to generate funds which can be re-invested, in whole or part, in further energy management activities
  - To sustain these energy efficiency gains by establishing and maintaining a management information system designed to ensure that information is delivered to those who need it on time and in a form which supports their managerial decision making.

Actual drafting of energy policy will depend on that organisation's corporate culture and management style. The policy will get wider acceptance if all the concerned parties have been given the opportunity to contribute to its formulation. All departmental representatives should be invited to make submissions to this when the policy is first formulated and again when it is reviewed. After the policy is drafted, it should be formally adopted and ratified by the Board of Directors of the organisation.

At the time of the launching of the project, it was found that only few plants had a formal energy policy though policies pertaining to environment, quality, safety, etc. existed. However, during the project interactions with number of plants, the plant managements realised its importance and BEE and TERI received a number of formal 'Energy Policy' declared by them. One or two of the selected policies in each of these sectors are attached with respective sectoral analysis chapter.

2.3 Policy guidelines

Based on the survey, field visits and interaction with industry association and other stakeholders, following guidelines/issues, which need immediate attention of industry were highlighted. It may be mentioned here that these guidelines are applicable not only to the six industrial sectors studied under this project but are applicable to other energy intensive industries as well.

2.3.1 *Top management commitment*

Demonstration of top management's participation in energy management and encouragement to the employees for the same is very important to the shop-floor workers. In fact, the CEO should make this visible to them. It sends right message for the employees at the lower end, which ensures their participation in this process. Top management commitment could be in the form of framing company's energy policy, and regular review of energy management projects and motivating employees on matters pertaining to energy conservation.

2.3.2 *Energy management cell*

All energy intensive industries should have a dedicated energy management cell with a full time 'Energy Manager' who will be responsible for overseeing its operations. The energy management cell should provide necessary structure and formalise the process of energy conservation thereby enhancing its efficacy with full support from top management. Besides energy manager, the cell should also have skilled persons in different disciplines. The cell should interact with manufacturing and other divisions like production, engineering, maintenance, utilities, and even finance. This will help in carrying out its activities like planned internal and external energy audits, conceptualisation and implementation of projects in close coordination with respective departments/divisions, carrying out educational campaigns etc. Thus, the cell will become the focal point for effective energy management in the plant. This dedicated working will also bring to the fore the energy issues in the minds of personnel working in different areas and will influence their decision-making.

2.3.3 *Small group activities*

To achieve the best results, all employees from top to bottom should be involved in energy management activities. Under this concept, a cross-functional team at the shop floor conceptualises a project, carries out measurements and implements with the help of concerned departments in the plant. Monitoring of its successful operation and actual savings realised are projected. This exercise creates awareness and gives a sense of confidence, ownership and achievement to employees for their contribution in this area. It was found during the course of field study and survey that plants using this activity have developed a culture of energy saving and the plant has benefited a lot in terms of sustainability of energy savings identified through this process.

2.3.4 *Capability enhancement/training and motivation*

Development of human capacity is very crucial to generate new and innovative ideas in-house for promoting energy management. The companies should develop specific training modules related to energy efficiency and management as part of its HRD training policy. This can be done by encouraging the plant personnel to participate in both internal and external training programs/workshop on these topics. The staff should be encouraged to publish achievements in energy management in both external and internal publications.

The plants should develop schemes to motivate their employees for sharing their ideas/ suggestions, slogans and also encourage them to take initiative for implementing energy conservation schemes etc. These could be in the form of monetary award, recognition and could be linked to their annual appraisal system.

2.3.5 *Monitoring and targeting*

Monitoring and targeting of key energy parameters help the industry to benchmark and compare its own performance over the years. Many studies and reports have identified poor quality of monitoring and record keeping as the key lacunae in energy management practices at the unit level. Monitoring is a must to keep track of performance of various energy consuming equipments to assess their operating efficiencies. Proper instrumentation in different sections of the plant and adequately trained staff to operate and manage them is a key requirement for monitoring. In fact, continuous monitoring would give better insight of the day-to-day operations and thus help in efficient management of the same.

Constitution of a small inspection group or 'Patrol', as is the normal Japanese term, is also a useful tool to enforce energy management. Patrols are normally undertaken by senior managers who go around the plant and meet the workers, talk to them about energy issues and plant's performance while asking them about their duties and efforts for energy conservation and performance improvement of equipments. This is very common in Japanese industries and the senior managers or the head of works undertake this exercise occasionally.

In the absence of energy consumption norms for various energy intensive industries in the country, these industries have adopted their own benchmarks. The common practice is to compare their performance with the best specific energy consumption figure in that particular sector/region or their own best figure achieved in the recent past. This effort may not be enough. The plants should also set their long-term goals and year-wise targets may be framed to achieve these goals.

Few plants in the country have achieved specific energy consumption figures which are very close to the best in the world, despite all the constraints. All plants should carefully plan out a roadmap leading to similar objective which will help them to be least cost producer of their product and become competitive globally.

2.3.6 *Budget for energy conservation*

Rational budgeting is a must for implementing energy saving measures in the plant. This should be made available under guiding policies of the company. However, each investment should be evaluated thoroughly on its technical feasibility and economic viability and IRR etc. Budget allocation should be done on yearly basis and should be known to energy management cell at the start of the year, for smooth execution of such activities. Top management can retain the power for sanctioning larger investments, but decision on small investments can be left to lower or middle management.

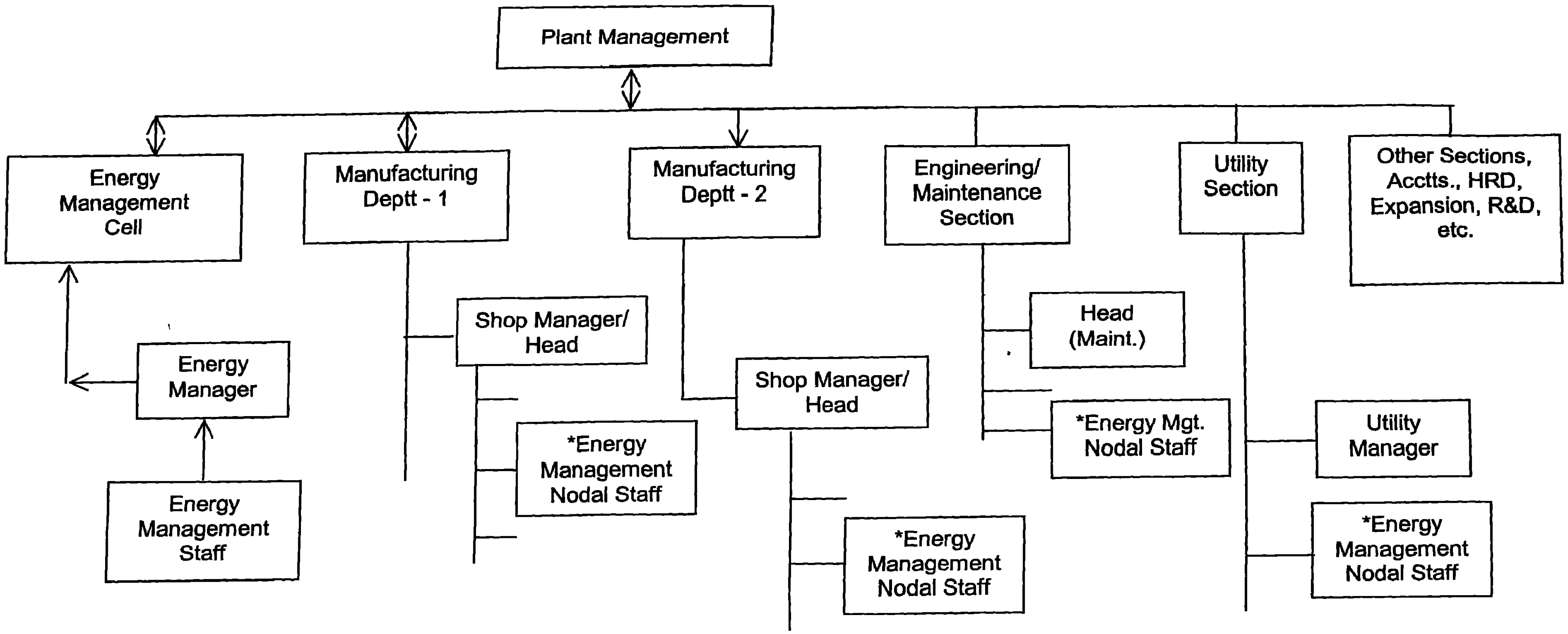
2.3.7 *Role of industry association and 'task force'*

Industry associations can play an important role to spread the culture of energy efficiency among its plants on a larger scale. In few selected energy intensive industrial sectors, such as, aluminium, cement, chlor-alkali, fertilizer, pulp & paper, petrochemicals, refinery, and textiles, BEE has set up a 'task force' of selected plants and association from that sector with an objective to promote energy efficiency on a sectoral basis. These forums could be utilised by these plants to showcase successful case studies on energy conservation in their [illegible]mises, share best practices, keep track of international scenario, [illegible]nological advances occurring in their field and market conditions etc. These forums can also help in framing energy consumption norms and targets for that particular sector.

2.4 Energy management structure

The energy management function, whether vested in one 'energy manager or co-ordinator' or distributed among a number of middle managers, usually resides somewhere in between senior management and those who control the end-use of energy. Exactly how and where that function is placed is a decision that needs to be made in view of the existing plant and corporate structure. Energy saving is more of a technical activity though it needs support from human resources for motivation and training, accounts department for financing and Chief executive's office to kick-start these initially. There is no single ideal home for all energy management activities and the optimum location may alter with time as the organisation will move from one phase of its energy management work to the next.

The most important question in the bigger industries is to decide whether all energy staff should be kept together in a combined unit or should they be dispersed across the organisation. A single unit will have its own advantages like shortest chain of command and economies of scale while dispersed locations with responsibilities delegated between sections may be more useful in the longer term as a way of integrated energy management across organisation's activities. Therefore, for large industries, it may be a better option to adopt a middle path i.e. a centrally located energy cell interacting with section specific units within a plant. Based on plant needs identified in the survey and field visits, and the Japanese experience in this area, a model organisation chart for energy management structure is given in Figure 2.4.



* These nodal officials report to their departmental head as well as to Energy Manager on energy management related activities and energy management implementation programme

Figure 2.4 Model organisation structure of Energy Management Cell

3

Aluminium Industry

3.1 Profile of the industry

The aluminium industry in India is highly concentrated, with just five plants accounting for the entire production capacity of 7,02,000 tonnes per annum. Four of these companies namely Hindalco, Madras Aluminium Company Ltd. (Malco), Indian Aluminium (Indal) and Bharat Aluminium (Balco) are in private sector and only National Aluminium Company Ltd. (Nalco), is a public sector company. This sector is passing through a consolidation phase and change in management recently. Balco was a 100 percent Government owned company (public sector) till May 2001. Now, 51 percent stake in this company is held by Sterlite group. Also, Birla group, the owner of Hindalco, has bought the majority stake in Indal. All these plants are integrated complexes except for Indal, which has its facilities spread over various locations in the country. Ownership details along with capacity and production figures for these producers are given in table 3.1.

Table 3.1 Ownership and production details

Company	Owner	Capacity (lac tonne)	Production (lac tonne) *	Capacity utilisation (%)
BALCO	Sterlite	1.00	0.96	96
HINDALCO	Birla	2.42	2.49	103
INDAL	Birla	1.17	0.44	37.18
MALCO	Sterlite	0.25	0.02	0.06
NALCO	Public sector	2.18	2.13	97.56
Total		7.02	6.03	85.92

* Figures pertaining to the year 1999-2000

The per capita consumption of aluminium in India is only 0.5 kg as against 25 kg in USA, 19 kg in Japan and 10 kg in Europe. Even the World's average per capita consumption is about 10 times of that in India. One reason of low consumption in the country could be that consumption pattern of aluminium in India is vastly different from that of developed countries. The demand of aluminium is expected to grow by about 9 percent per annum from present consumption levels. This sector is going through a consolidation phase and existing producers are in the process of enhancing their production capacity so that a demand-supply gap expected in future is bridged. However, India is a net exporter of alumina and aluminium metal at present.

In order to develop the guidelines for energy management policy for the plants comprising the aluminium industry, it was decided to undertake a questionnaire survey that was followed up by plant visits. Questionnaires were sent to all the five aluminium producers listed above. The response however, came from only two producers. The plant visits were also undertaken in these two plants. Incidentally, both these plants belong to one group and supposedly are quite progressive in taking initiatives in the field of energy management.

Salient features of Indian Aluminium industry

- Highly concentrated industry with only five primary plants in the country
- Controlled by two private groups and one public sector unit
- Bayer-Hall-Heroult technology used by all producers
- Electricity, coal and furnace oil are primary energy inputs
- All plants have their own captive power units for cheaper and un-interrupted power supply
- Energy cost is 40% of manufacturing cost for metal and 30% for rolled products
- Plants have set internal target of 1-2% reduction in specific energy consumption in the next 5-8 years
- Energy management is a critical focus in all the plants
- Two plants have declared formal energy policy
- Each plant has an Energy Management Cell
- Achievements in energy conservation are highlighted in the Annual Report of the company
- Energy targets are based on best energy figures achieved in their sector/region and by the plant itself in the past
- Generally, government policies were rated as conducive to energy management
- 'Task force' formed by BEE in this sector to work as a catalyst in promoting energy efficiency
- High cost of technology is the main barrier in achieving high energy efficiency

3.2 Analysis of Part A (Quantitative details) of questionnaire

Hindalco and five units of Indal responded to the questionnaires. Whereas Hindalco plant at Renukoot is an integrated unit, Hirakud and Alupuram units of Indal are smelters and Taloja, Belur and Kalwa units are secondary units i.e. they produce fabricated aluminium products. Summary of the data collected from the plants is given in Annexure 3.1. Information provided by these companies is summarised in following sections.

3.2.1 Installed capacity and capacity utilisation

Installed smelter capacity of both the companies who responded, is given in Annexure 3.1. Their capacity utilisation exceeds 100 percent for last 3 years for which figures were provided. However, for secondary products, capacity utilisation varies from as low as 50 percent to more than 100 percent, probably depending on the demand for such products in the market.

3.2.2 Raw material and Product type

Bauxite and calcined petroleum coke are primary raw materials for this industry. However, alumina is raw materials for smelters and aluminium metal is raw material for fabrication units (rolled products) of Indal.

3.2.3 Fuel usage

Coal, furnace oil and electricity are primary energy inputs in aluminium production. Coal is primarily used to generate steam, which is used in the process while fuel oil is mainly used in Calcination of alumina and various furnaces in fabrication plants. Electricity is the major energy input in aluminium production and is considered to be a prime factor in determining economics of aluminium production. Hence, all primary metal producers have installed their own captive power plants to supply cheaper and uninterrupted power for their use. Majority of electricity consumed in this industry is supplied by their captive power plants.

3.2.4 Technology Status

Invented over 100 years ago, Bayer-Hall-Heroult is the only available commercial technology, even today, for the production of aluminium. Alumina is the basic raw material for the production of aluminium metal through electrolytic process. The production of alumina obtained from bauxite, a mineral containing upto 60% in the form of mono/trihydrate is carried out through the Bayer route, which is an extractive hydro-metallurgical process.

3.2.5 Energy performance

The aluminium industry is highly energy intensive. Energy cost as percentage of manufacturing cost is around 40% for metal production and around 30% for rolled products.

The specific electricity consumption for all the three smelters ranged between 15000 to 15500 kWh per tonne of metal, whereas thermal energy consumption for the integrated plant was around 0.6 million kcal per tonne. For fabrication plants, specific electricity consumption was in the range of 1160 to 1481 kWh per tonne of rolled product. National and international values of specific energy consumption for alumina and aluminium are given in Table 3.2.5.

Table 3.2.5 Specific energy consumption comparison

Product	Unit	National	International
Alumina	GJ/MT	–	12.05 (World best practice) 9.00 (for Stade Plant., Germany)
Aluminium	*DC-kWh/MT	14199 (Hindalco)	13200 (Best in world, Pechiney, France)

* DC kWh/MT to produce aluminium metal only, excluding auxiliaries and consumption in alumina plant

Source. Hindalco Industries Ltd, 2002

In response to future target set internally by the plants themselves for reduction in specific energy consumption, quite a few of them provided the figures. One plant gave exact electrical and thermal specific energy consumption reduction figures both for alumina and metal by the year 2010. Others also provided their kWh per tonne targets for metal and rolled products till 2010. Overall, plants have a set a target of 10% reduction in specific energy consumption in the next few years.

3.2.6 Major energy saving measures implemented in the aluminium sector

All the plants have implemented a number of energy conservation measures in the past and have specific plans to implement a few in the near future. Investments required for implementing these measures are funded through internal reserves. Major energy conservation measures implemented in the last three years in this sector are given in table 3.2.6.

Table 3.2.6 Major energy saving measures implemented in aluminium industry

1.	Installation of data acquisition system
2.	Installation of energy efficient screw compressors
3.	Installation of PLC controlled burners in furnaces
4.	Installation of de-super heaters for better heat transfer and steam saving in alumina refining
5.	Installation of liquid vapour hydro cyclone in evaporation feed flash tank to avoid caustic entrainment to the hotwell water and facilitates more flashing
6.	Reduced compressor running hours by modifying pipe sizes, modifying the volumetric efficiencies, by providing air conservation ejector nozzles and regulating the pressure as per requirement.
7.	Installation of technologically upgraded recuperator in place of shell type in melting furnace.
8.	Reduction in oil consumption by installing fuel magnetizer and fused silica launders and reduction of furnace preparation time by using metal transfer trucks.
9.	Modification of digestion unit flash tank train by utilizing additional tank spared from slurry heater condensate flashing circuit.
10.	Installation of variable frequency drives
11.	Utilisation of energy efficient lighting system

3.3 Analysis of Part B (Energy management practices) of questionnaire

This part essentially deals with the existing energy management practices in the plants, details of which are given in the following sections.

3.3.1 Energy/Environment/Quality Policy

All the plants that responded have a formal Environment and Quality policy. However, only two units reportedly had a formal energy policy. The policy statements issued by these plants are given in Annexure 3.2. It must be mentioned here that few other units have also declared their energy policies formally now. All these plants have displayed these policies publicly too.

3.3.2 Commitment to energy conservation

Energy management is a critical focus of the top management in all the units who responded. They participate in planning and review of various management projects on a regular basis. In fact, annual report of these companies have a detailed mention of management policies towards energy efficiency. Energy conservation measures taken by them in the last one year and achievements in this regard are also highlighted in the report. One plant reported that energy management policies are decided through a participatory cross-functional approach while other units said that senior level managers from different departments are involved in the formulation of policy.

3.3.3 Energy management cell, its organisation and role

Aluminium industry understands the importance of energy conservation and all the units except one have set up energy management cell (EMC) in one form or the other. This cell has members drawn from various sections of the plant who have additional responsibility of energy conservation other than related to maintenance or production. Most of the plants informed that postings in the energy management cell are not rotated i.e. the members are permanent in the cell. However, one unit rotates these postings every three years to increase the awareness and commitment of the plant personnel. Energy management structure employed in Hindalco is shown in Figure 3.3.3.

The job of the EMC is to generate the energy management plan, identification and execution of energy conservation projects in the plant. All the plants reported that EMC also monitors the energy performance of equipments and plant on a continuous basis and prepares energy consumption status report for

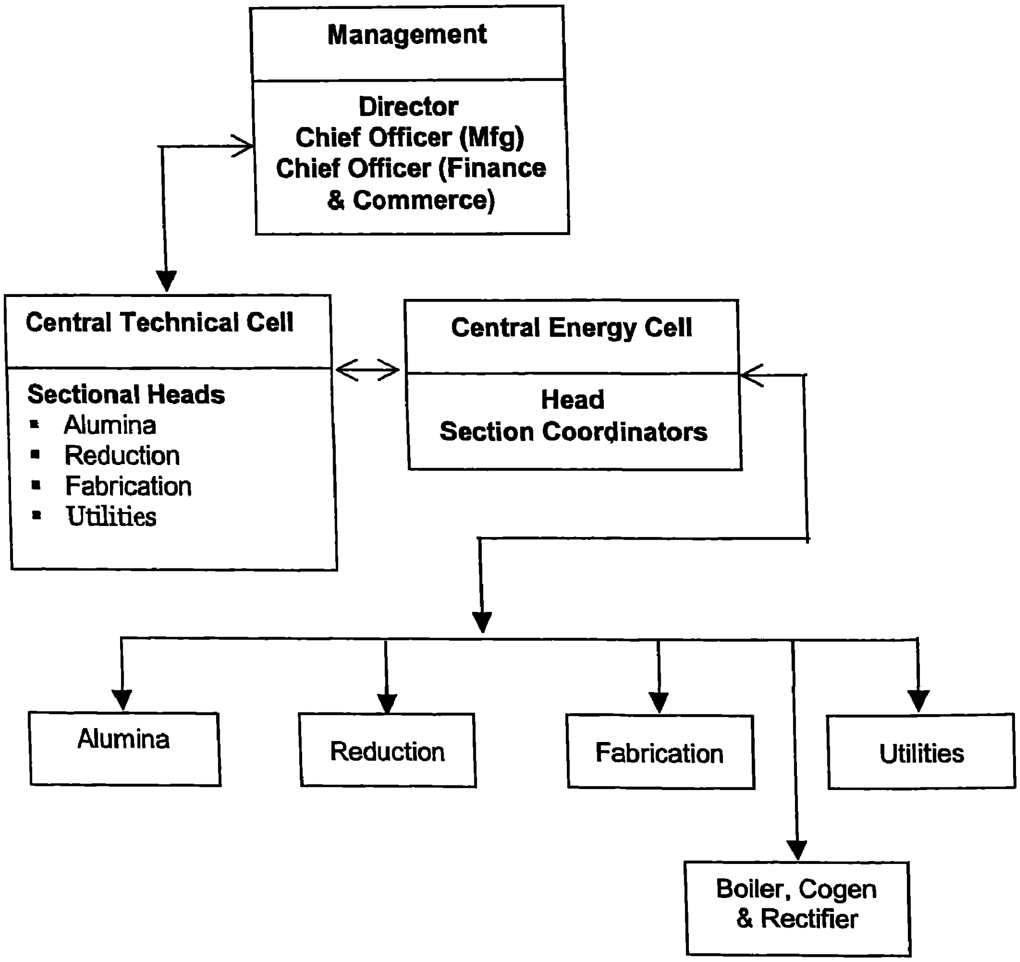


Figure 3.3.3 Energy management structure in Hindalco

review by different levels of management. Energy consumption reporting to top management is done on monthly basis, and to plant sectional heads on daily/weekly and monthly basis. Energy conservation plan for the next year is prepared in advance. The cell also interacts with top management frequently and with different departments in the plant very regularly.

3.3.4 Small group activities

The response on this activity from the plants was ambiguous. Few said that shop floor, junior and middle management personnel meet on a monthly basis to discuss energy conservation related issues in the plant. However, clearly not much emphasis seems to be there at present on this aspect except one or two plants.

3.3.5 Energy audit

Almost all the plants utilise energy audit to identify potential of energy savings in their units. Every plant has the internal expertise to carry out energy audit in-house. However, few plants take help of external energy auditors also. Frequency of audit varies from once a year to once in three years. Few plants are situated in those states where energy audit is mandatory. There is no response from the plants on its usefulness in improving the energy management in the industry.

3.3.6 Energy conservation budget

Most of the plants have no separate budget for energy conservation. Decision on investment to be incurred on energy conservation is taken by the top management and is implemented by the sectional heads. These decisions are based on techno-economic analysis and return on investment is an important criteria. Emphasis is given to those projects which can be executed in-house.

3.3.7 Setting of targets

Energy conservation targets are set on the basis of reduction possibility in last year's energy consumption and the best energy figures for similar plants in the region or the sector. Some companies set second best specific energy consumption figures achieved in a month last year as the target for the next year.

3.3.8 Motivation

There are a number of schemes in aluminium plants to educate and motivate the plant personnel. All these schemes are designed in a way to ensure maximum participation of the employees. Few units encourage them to give suggestions and slogans on energy conservation while few organise in-house training programs on energy management for their employees. Some of the plants encourage their employees to publish their achievements in energy conservation in journals and internal newsletters.

There is no set budget for providing external training to their employees on yearly basis and this training is imparted as per requirement in the plant.

3.3.9 Barriers for energy conservation

High cost of technology which these plants want to adopt for improving their energy efficiency is the main barrier. This again, however, is dependent upon the size of the plant viz. larger aluminium producers feel that there is no barrier in achieving higher energy efficiency levels in their plants. Interestingly, higher interest charges or production disruption was not cited as a barrier by any plant since all the players are big and very strong financially.

3.3.10 Government Policies

Government of India has accorded top priority to energy conservation in the country and to give further impetus in this area, Bureau of Energy Efficiency has been set up through the Energy Conservation Act 2001. The Bureau has helped this industry in forming a 'Task Force' with participation from all the five producers aiming to improve energy efficiency in this sector. Most plants seem satisfied with the Government policies to promote energy conservation in this sector. Those who said no, wanted additional support in the legislative, equipment subsidy and R&D support etc.

3.4 Field visits

3.4.1 Hindalco Industries Limited, Renukoot

Hindalco, a flagship company of the Aditya Birla group, is located at Renukoot, UP and is India's largest integrated producer of aluminium metal. The company had commenced its operations in 1962 with smelting capacity of 20,000 tonnes per year (TPY) and alumina refining capacity of 40,000 tonnes per year. The company has increased its aluminium smelting capacity to 2,42,000 TPY and alumina to 4,50,000 TPY through continuous expansion, technological upgradation and optimum capacity utilisation of its facilities. Electricity is one of the vital input for production of aluminium metal. A captive power plant at Renusagar, 30 km away from the plant, has been set up with installed capacity of 581 MW and a co-generation plant of 37 MW at plant itself. The company has three main divisions for aluminium production, namely Alumina plant for refining of bauxite into alumina, Reduction plant for converting alumina into aluminium metal and Fabrication plant for converting primary aluminium into different value added semi finished fabricated products such as re-draw rods, rolled and extrusion items. Process flow sheet for alumina and smelter sections are given in Annexure 3.3.

Capacity utilisation of various production facilities is more than 100 percent, which helps in lowering specific energy consumption in the plant. The unit has a formal quality and environment policies, and during the course of our study energy policy was also formally declared. The management feels that this policy will help in providing clarity and a focused approach throughout the organisation in meeting the desired objectives. All these policies are publicly displayed. An ISO 14001 and ISO 9002 company, it has received a number of awards in the field of business excellence, quality, energy conservation and its efforts for preserving the environment. In the field of energy conservation, the company has the prestigious 'National Energy Conservation Award', administered by Bureau of Energy Efficiency, Ministry of Power, Government of India, many times in the past. In fact, in 2002 only, it has won the first prize in Aluminium sector. Hindalco is one of the least cost producer of aluminium in the World today.

Plant energy conservation activities coverage is a regular feature of the annual report of the company. For formulating energy management policies at corporate level, a discussion based on cross-functional approach is adopted and all levels of management are involved in developing corporate energy management plan.

3.4.1.1 Energy conservation cell and its activities

The plant has a Central Energy Cell, which is responsible for coordinating all activities related to energy conservation. This cell is guided by Central Technical cell comprising of different plant heads. The Central Technical Cell is directed by one Management Group headed by CEO of the company.

There are five energy cells at section level, which are headed by senior managers of these sections. These cells are responsible for identifying, planning, scheduling, budgeting and implementation. Central energy cell works in close coordination with these cells. It reviews the plant processes and expansion activities besides implementing new technologies for energy conservation. Benefits or savings achieved after implementation are monitored by the cell. The cell is also responsible for regular energy auditing in the plant internally as well as through external agencies.

3.4.1.2 Initiatives to promote energy management

Small group activities are organised on a regular basis at different levels in the plant, in which energy conservation aspects are also discussed. To assess the potential of energy conservation, energy audits are conducted both internally as well as externally on a regular basis. Plant has an internal system of setting targets for specific energy consumption at sectional level for different products. These targets are based on second best figure achieved in the last one year and best figures in the sector. The plant is also conscious of best international norms for similar plants in the sector. The company has well structured suggestion schemes to encourage employees to come out with their ideas on energy conservation and employees are suitably rewarded for viable suggestions.

3.4.1.3 Investment in energy management projects

Company has strong commitments towards energy conservation. Investments required for economically viable energy conservation projects (payback of upto three years) are normally approved. Thorough techno-economic analysis of all the projects is carried out with a preference given to those projects that can be executed in-house by the plant. The plant has incurred an investment worth Rs 102 crores in the year 2001-02 with saving realized as 7.7 crores per year. The management has set a target of 1% reduction in energy consumption in smelters by the year 2005 from the present levels and 10% reduction in furnace oil consumption by the same year.

3.4.1.4 Barriers and Government policies

The management feels that there are no constraints in implementation of energy efficiency programs in their plant. Also, the present Government policies are conducive to promote energy conservation in the industry.

The state, in which the company is located, does not have any legislation for mandatory energy audits. However, it is felt that mandatory energy audits would not go a long way in promoting energy management since the urge for the same should come from within.

3.4.1.5 Major issues for effective energy management policy

It was felt that top management commitment towards energy conservation plays the most important role in promoting energy efficiency at the plant level. At the same time, a full time manager to head energy management cell is a must to coordinate these activities. In-house R&D to develop plant specific solutions, continuous interaction with equipment and technology suppliers, regular energy audits and monitoring and targeting of energy consumption at regular levels were some other important issues identified by the management.

3.4.2 Indian Aluminium Limited (Indal), Hirakud

Indal was the first to set up aluminium manufacturing facilities in India in the year 1938. It is now a member of the Aditya Birla group who bought over the ownership from ALCAN group of Canada recently. Indal is today vertically integrated through all stages of business i.e. from bauxite mining to foil rolling. The smelter unit of Indal at Hirakud in Orissa, which is engaged in the production of primary aluminium by electrolysis of alumina dissolved in molten cryolite bath is one of the several units of Indal. The refined alumina used in the plant is mainly sourced from the company's alumina refinery plants at Muri in Bihar and Belgaum in Karnataka. The technology adopted in Hirakud is Horizontal Stud Soderberg (HSS) type. The smelter which started operation in the year 1959 with 10,000 tonnes per annum has undergone expansion in stages to reach the present capacity of 30,000 tonnes per annum.

Since beginning, the plant was importing power from the State grid to meet its requirements. Due to unstable supply of power & continuous increase in power tariff, aluminium production becomes unviable. Thermal captive power plant of 67.5 MW capacity was thus set up in 1993-94 to maintain the cost competitiveness in aluminium production. The annual energy bill in the plant is around Rs 80 crores of which only Rs 1 crore is for furnace oil and the rest for electrical energy.

Capacity utilisation of smelter is around 100 percent for last three years. High capacity utilisation along with captive power is helping the plant in lowering specific power consumption. An ISO 14001 and ISO 9002 company, formal quality, environment and energy policies have been declared separately. A number of national and international awards have been won in the field of quality, environment, safety and energy conservation. The plant has won the prestigious "National Energy Conservation Award" administered by BEE, MoP, a number of times including first prize on two occasions. In the year 2002, the plant has won the special prize in the aluminium sector.

Energy conservation activities are covered in the annual report of the company as a regular feature. Resource conservation and environment protection are the fundamentals for sustaining its smelting business. In a continuous effort to conserve resources and improve the production capacity, the plant has introduced the concept of Full Business Potential (FBP) which has helped in achieving the desired results.

3.4.2.1 Energy Conservation Cell and its activities

The plant has an Environment and Resource Conservation Cell (E&RC Cell) which focuses on resource conservation in addition to environmental issues. Chief Executive (Locational head) of the plant is the Chairman of the Cell. Deputy Manager, R&D acts as the Convenor of this cell and energy conservation is his additional responsibility of the cell. Besides these two persons, the heads of engineering, production and maintenance centres, design and planning, materials, environment and community development are also members of this cell. This cell looks after measurements, monitoring, managing and implementing new in-house projects and newer technologies for energy conservation in the plant. Important decisions regarding conducting energy audits through external agencies and finance for implementing different measures are taken in their monthly review meeting.

3.4.2.2 Initiatives to promote energy management

The plant has a well defined program for Small Group Activity (SGA) for energy conservation. The plant has adopted World Class Manufacturing (WCM) program that aims to achieve manufacturing excellence by working towards a culture that involves zero defects, accidents, breakdowns, pollution, customer complaints and losses. As part of this initiative, with zero loss objective, SGA teams have been constituted, which are cross-functional teams and work on a specific energy conservation project in a particular section of the plant. A SGA team is responsible for conceptualising the project, discuss it with concerned persons who will provide necessary resources for implementation. Regular monitoring after implementation is done to ensure its sustainability. Energy audits have been carried out through external agencies as well as internally too to assess the potential of energy saving and these savings have been realised subsequently. Employees are encouraged to come out with their ideas on energy conservation and are suitably rewarded for viable suggestions.

3.4.2.3 Investment in energy management projects

Investments required for technically feasible and economically viable energy conservation projects are approved by the management and subsequently implemented.

A total of Rs 211 lacs saving in energy was realised in the year 2001-02 through an investment of Rs 240 lacs.

3.4.2.4 Barriers, Government policies and major issues for effective management policy

The management feels that there are no constraints in implementing energy efficiency program in the plant. As far as the Government policies are concerned, it is felt that if custom duties are lowered on technologies and equipments which are used by the aluminium sector, that would certainly help the plant in the long run. Management would like to adopt energy efficient 'pre-baked anode' technology in place of existing HSS type, if certain incentives are given. As of now, the replacement is not economically viable.

Till now, energy audit is not mandatory in the state of Orissa, where this plant is located. Though the plant has regularly availed the services of external agencies in the recent past, but the management feels that energy audit should not become mandatory. The decision of taking help of external consultant/expert should be left to the plant and should not be forced. Because, the plant management is very much aware about the need of energy conservation and any external help in this regard should be need based.

Top management commitment towards energy conservation, promotion of small group activities, regular energy audits and benchmarking of energy consumption were some of the important issues identified by the management.

3.5 Issues to be stressed while framing energy policies of the aluminium industry

The aluminium industry in India has come a long way after deregulation in the mid 1980s. This sector is highly concentrated with only two private industrial groups controlling four companies and one public sector plant. However, this is a very competitive sector with aluminium prices in the country linked to LME prices and hence these plants have to operate in a globally competitive market. Few plants have taken steps to upgrade and modernise by adopting latest technologies and practices that have been developed by international suppliers. Almost all the units have installed their own captive power plants since energy, particularly electricity, is like a raw material to them and they want good quality and uninterrupted power for their operation. All the plants are continuously identifying ways and means to reduce their cost of production with special emphasis on energy conservation because it directly affects their bottomline. In fact, one of the plant in this sector is amongst the lowest cost producer of aluminium in the World.

Apart from achieving energy saving through technological upgradation in plant and machinery, there are a number of softer approaches that need to be taken to improve the energy performance at the plant level. Few important issues that emerged from the analysis of the questionnaire, field visits to the plant and from direct interaction with the experts in this area are highlighted below:

3.5.1 Top management commitment

A strong commitment towards energy conservation from the top management will send right signal down to the shop floor worker. An energy policy statement will work as a catalyst in this regard. The policy statement should also make a commitment to reduce specific energy consumption by certain percentages in the next 5 to 10 years. Daily monitoring of section-wise energy consumption levels by their respective heads and comparison with the set norms would show the importance attached to operators and supervisors. Deviation from the set targets should be analysed thoroughly and corrective action should be initiated.

3.5.2 Energy Management Cell

It is very important for energy intensive industries like aluminium to have a dedicated energy management cell with a full time 'Energy Manager' who will be responsible tor overseeing its operations. Most of the plants in this industry have department/cell who look after energy conservation activity, which is an additional responsibility and not necessarily a prime one. The energy management cell should provide necessary structure and formalise the process of energy conservation thereby enhancing its efficacy with full support from top management. Besides energy manager, the cell should also have skilled persons in different disciplines to take care of its need. The cell should interact with manufacturing and other divisions like maintenance, utilities and even finance, which will help in carrying out its activities like conceptualisation and implementation of projects, carrying out educational campaigns etc and are beneficial to effective energy management. This dedicated working will also bring to the fore the energy issues in the minds of personnel working in different areas and will influence their decision making.

3.5.3 Small group activities

It is very important to involve every employee from top to bottom to achieve best results in the area of energy conservation. Operator and foremen level employees form a team to work on a specific energy conservation project. This cross-functional team conceptualises the project, carries out the measurements and after discussion with management implements it too with support of concerned departments. Monitoring of its successful operation and actual savings realised are also calculated and presented to the management. Through this exercise, not only the awareness among the employees about the energy conservation would be created but also they would feel a sense of ownership and achievement. A proper reward scheme would also be helpful in encouraging employees to share their valuable ideas.

3.5.4 Task Force to work as a catalyst

Aluminium Association Of India (AAI) can play an important role to spread the culture of energy efficiency among its plants at the national level. In fact, BEE has helped in forming a 'Task Force' with participation from all the five plants with an objective to promote energy efficiency in this sector. This forum can be utilised by these plants to showcase successful case studies on energy conservation in their plants, share best practices, keep track of international players and should collect the information about their energy consumption, technologies, market conditions etc. Based on the information collected, this forum should frame the norms for various types of products and also revise it time to time.

3.5.5 Incentives from the Government

Although, most of the aluminium plants feel that present Government policies are conducive to promote energy management. However, following policy initiatives from the Government side will certainly help energy intensive sectors like aluminium in becoming more energy efficient.

- Reduce custom/excise duty on equipment used for energy saving purposes like replacement of HSS technologies process by pre-baked anode making
- Give tax relief to those plants who develop in-house technologies used for energy conservation
- 100% depreciation in the first year on energy saving equipments

Annexure 3.1

Summary of date collected from different plants

Plant A

Sl. No.	Description	Units	Year 1998-99	Year 1999-00	Year 2000-01
1	Products (MT)				
	Alumina		421486	453305	476700
	Aluminium		240926	248930	251492
	Redraw roads		51197	49018	43946
	Rolled & extrusion		56663	73649	81413
2	Specific Energy Consumption				
	Thermal (Alumina)	Ton of steam/MT	3.843	3.681	3.552
	Thermal (Aluminium)	Million kCal/ MT	0.659	0.679	0.581
	Electrical (Alumina)	kWh/MT	479	445	422
	Electrical (Aluminium)	kWh/MT	15332	15217	15365
3	Energy Consumption and Cost				
	Electrical Energy	MWh	3996358	4118464	4185473
	Cost	Rs. lakh	26225	26059	28307
	Coal	tonnes	411914	402329	394676
	Cost	Rs. lakh	3114	2875	2948
	Furnace oil	KL	61365	62326	62638
	Cost	Rs. Lakh	3949	5248	6439
4	Future target for reduction in specific energy consumption by the year 2010				
	Electrical (Alumina)	KWh/MT	49		
	Electrical (Aluminium)	KWh/MT	160		
	Thermal (Alumina)	MT of steam/ MT	1.06		
	Thermal (Aluminium)	%	10		

Plant B & C

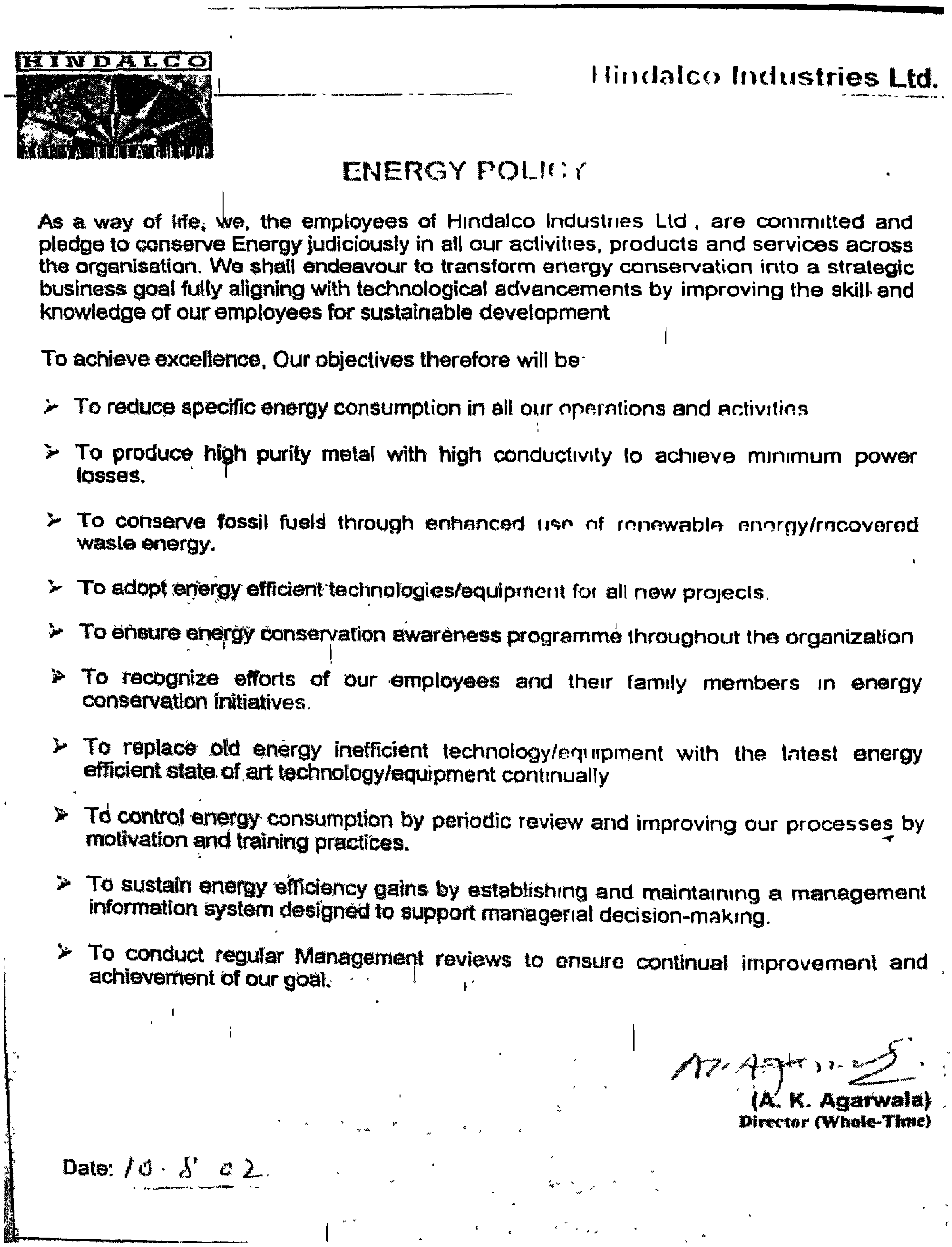
Plant	Description	Units	1998-99	1999-00	2000-01
	Products				
B	Aluminium	MT	28730	29830	30060
C	Aluminium	MT	13463	13620	13915
	Specific Energy Consumption				
B	Electrical	KWh/MT	15161	15044	15042
C	Electrical	KWh/MT	15421	15436	15119
	Energy Consumption and Cost				
B	Electrical Energy	MWh	482800	494700	501300
	Cost	Rs lakh	8310	7947	7882
C	Electrical Energy	MWh	233063	236314	236616
	Cost	Rs lakh	4010	5362	5401
B	Furnace oil	KL	1256	1233	1285
	Cost	Rs. lakh	86	110	138
C	Furnace oil	KL	614	962	1056
	Cost	Rs lakh	35	76	119
	Future target of specific energy consumption by the year 2010				
C	Electrical (Aluminium)	KWh/MT	14800		

Plant D, E & F

Plant	*Description*	*Units*	*1998-99*	*1999-00*	*2000-01*
	Product				
D	Rolled & Extrusion	MT	31596	22584	26302
E	Rolled	MT	31095	33686	39341
F	Foil & laminates	MT	5488	6372	6588
	Specific Energy Consumption				
D	Electrical	KWh/MT	1420	1481	1461
E	Electrical	KWh/MT	1297	1283	1160
F	Electrical	KWh/MT	2526	2224	2138
	Energy consumption and cost				
D	Electrical	MWh	47393	34799	39522
	Cost	Rs lakh	1894	1512	1695
E	Electrical	MWh	39300	43300	45600
	Cost	Rs lakh	1473	1754	1843
F	Electrical	MWh	14327	14780	14768
	Cost	Rs lakh	586	620	629
D	Furnace oil	KL	4411	3768	4706
	Cost	Rs lakh	259	316	474
E	Furnace oil	KL	945	3356	1898
	Cost	Rs lakh	54	205	200
F	Furnace oil	KL	542	560	482
	Cost	Rs lakh	32	52	51
E	Diesel	KL	285	86	50
	Cost	Rs lakh	34	9	7
F	Diesel	KL	98	115	103
	Cost	Rs lakh	16	19	18
	Future target of specific energy consumption by the year 2010				
D	Electrical	KWh/MT	1250		
F		KWh/MT	2000		

Annexure 3.2

Energy policies



Hindalco Industries Ltd.

ENERGY POLICY

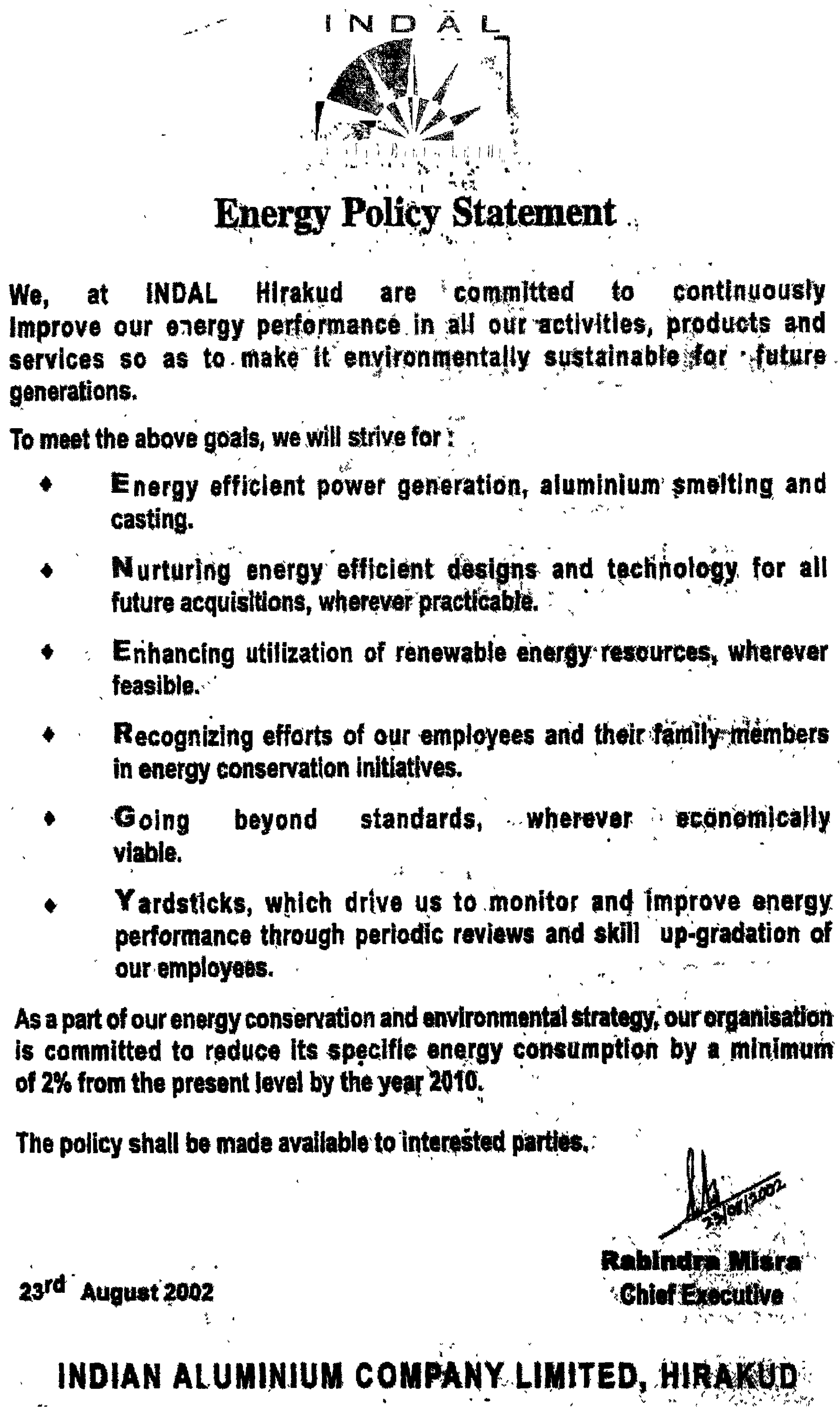
As a way of life, we, the employees of Hindalco Industries Ltd , are committed and pledge to conserve Energy judiciously in all our activities, products and services across the organisation. We shall endeavour to transform energy conservation into a strategic business goal fully aligning with technological advancements by improving the skill and knowledge of our employees for sustainable development

To achieve excellence, Our objectives therefore will be

- To reduce specific energy consumption in all our operations and activities
- To produce high purity metal with high conductivity to achieve minimum power losses.
- To conserve fossil fuels through enhanced use of renewable energy/recovered waste energy.
- To adopt energy efficient technologies/equipment for all new projects.
- To ensure energy conservation awareness programme throughout the organization
- To recognize efforts of our employees and their family members in energy conservation initiatives.
- To replace old energy inefficient technology/equipment with the latest energy efficient state of art technology/equipment continually
- To control energy consumption by periodic review and improving our processes by motivation and training practices.
- To sustain energy efficiency gains by establishing and maintaining a management information system designed to support managerial decision-making.
- To conduct regular Management reviews to ensure continual improvement and achievement of our goal.

(A. K. Agarwala)
Director (Whole-Time)

Date: 10 · 5 · 02



INDAL

Energy Policy Statement

We, at INDAL Hirakud are committed to continuously improve our energy performance in all our activities, products and services so as to make it environmentally sustainable for future generations.

To meet the above goals, we will strive for :

- **E**nergy efficient power generation, aluminium smelting and casting.
- **N**urturing energy efficient designs and technology for all future acquisitions, wherever practicable.
- **E**nhancing utilization of renewable energy resources, wherever feasible.
- **R**ecognizing efforts of our employees and their family members in energy conservation initiatives.
- **G**oing beyond standards, wherever economically viable.
- **Y**ardsticks, which drive us to monitor and improve energy performance through periodic reviews and skill up-gradation of our employees.

As a part of our energy conservation and environmental strategy, our organisation is committed to reduce its specific energy consumption by a minimum of 2% from the present level by the year 2010.

The policy shall be made available to interested parties.

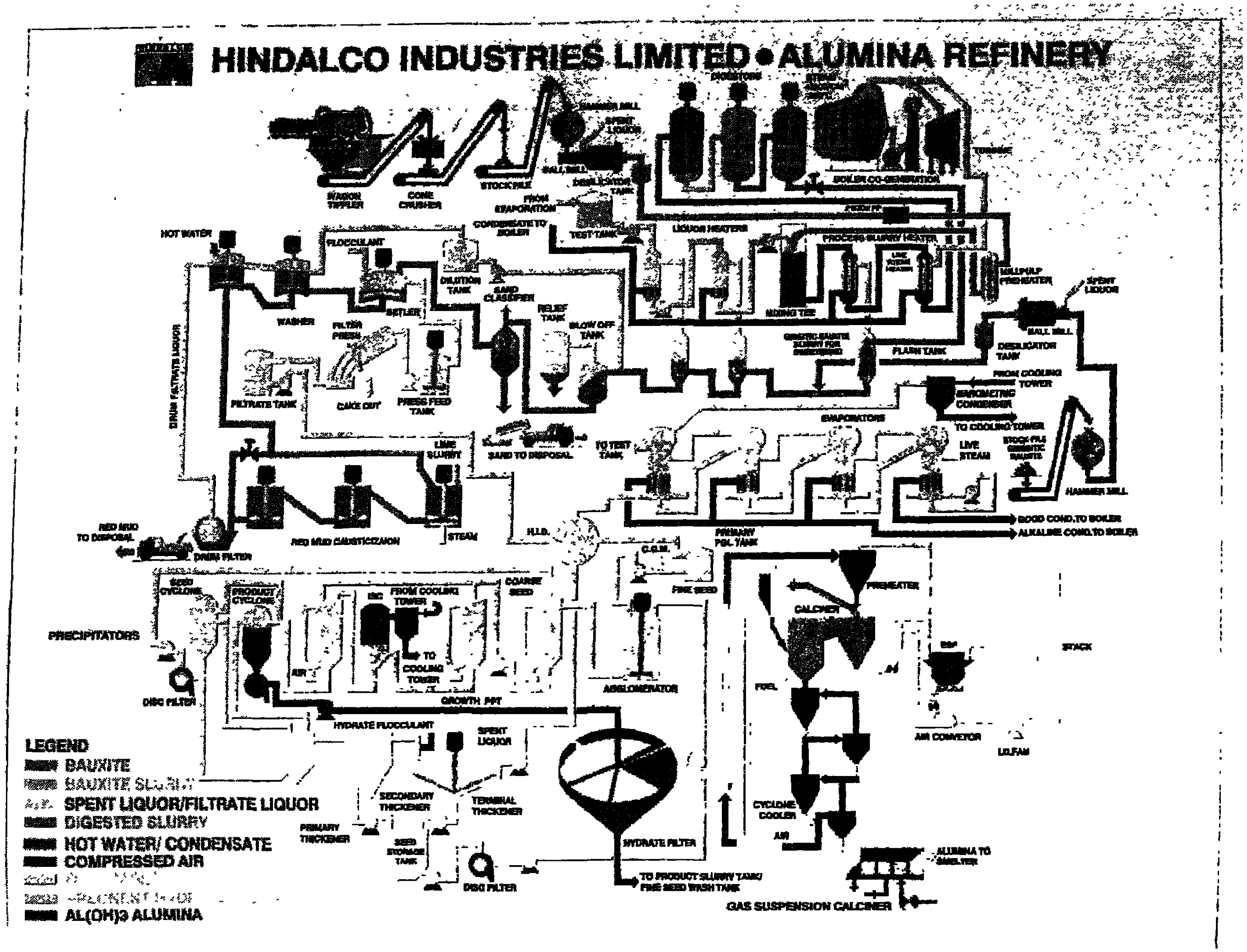
Rabindra Misra
Chief Executive

23rd August 2002

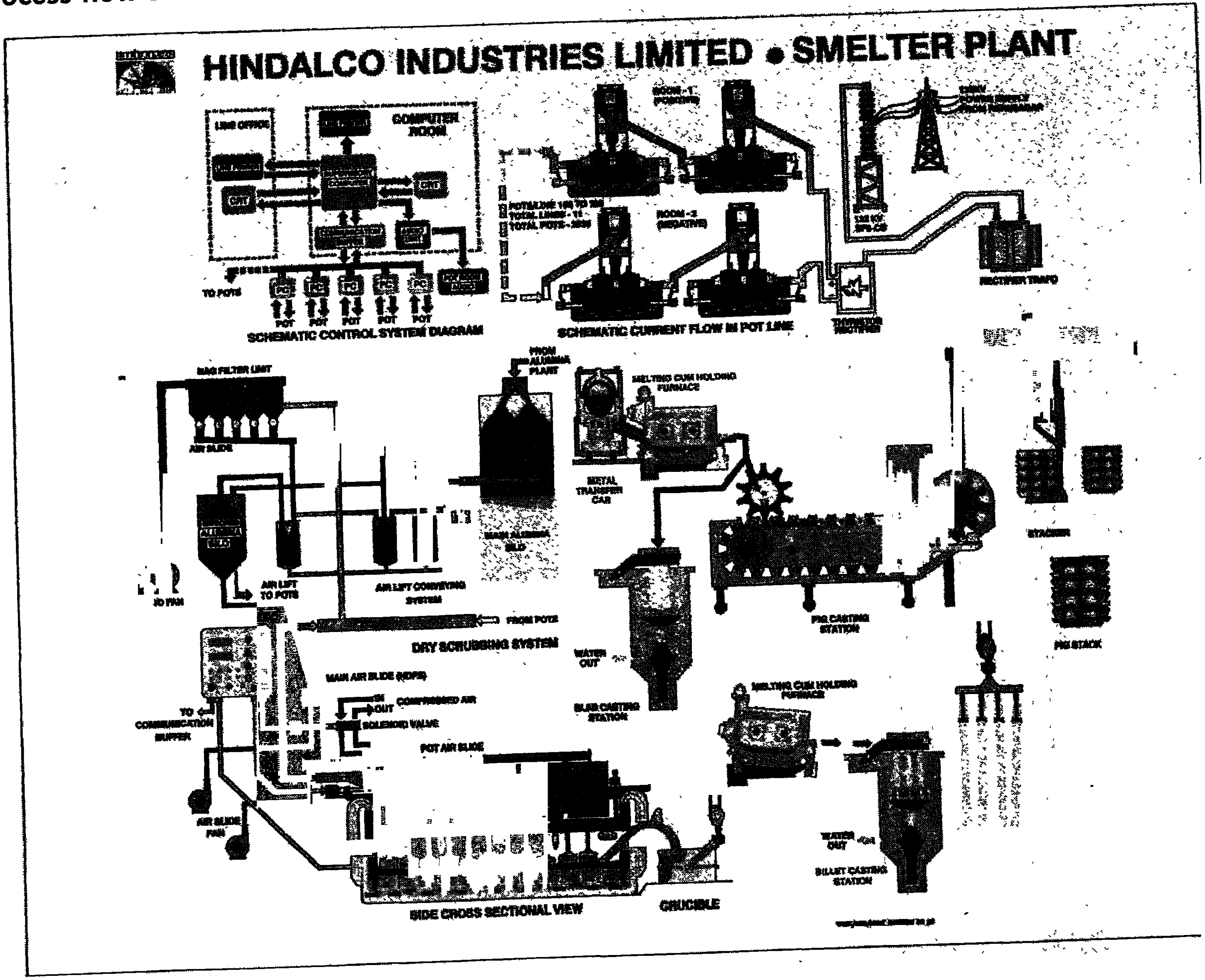
INDIAN ALUMINIUM COMPANY LIMITED, HIRAKUD

Annexure 3.3

Process flow sheet for alumina section at Hindalco Industries Ltd.



Process flow sheet for smelter section at Hindalco Industries Ltd.



4

Cement Industry

The Indian cement industry is the 2nd largest cement producer in the world, with an installed capacity of 144 million tonnes. The industry has undergone rapid technological up-gradation and vibrant growth during the last two decades, and some of the plants can be compared in every respect with the best operating plants in the world. The industry is highly energy intensive and the energy bill in some of the plants is as high as 60% of cement manufacturing cost. Although the newer plants are equipped with the latest state of the art equipment, there exists substantial scope for reduction in energy consumption in many of the older plants by adopting various energy conservation measures.

The Indian cement industry is a mixture of mini and large capacity cement plants, ranging in unit capacity per kiln as low as 10 tpd to as high as 7500 tpd. Majority of the production of cement in the country (94%) is by large plants, which are defined as plants having capacity of more than 600 tpd. At present, there are 124 large rotary kiln plants in the country. These plants are a mix of public and private sector. Except for the plants under Cement Corporation of India (CCI) and few state government enterprises, almost all other plants in the country are privately owned. The cement industry has large established players who are in the business for a long time. Over the past few years, it has been seen that some of these domestic companies are increasing their capacities through mergers and acquisitions. In addition, the industry has also seen the emergence of multinationals, which is expected to further enhance the competitiveness in the cement sector. As a result, the cement industry is now seeing a structural shift with the emergence of large companies having capacities which are of a global scale.

The Ordinary Portland Cement (OPC) enjoys the major share (56%) of the total cement production in India followed by Portland Pozzolana Cement (PPC) and Portland Slag Cement (PSC). A positive trend towards the increased use of blended cement can be seen with the share of blended cement increasing to 43%. There is regional imbalance in cement production in India due to the limitations posed by raw material and fuel sources. Most of the cement plants in

India are located in proximity to the raw material sources, exploiting the natural resources to the full extent. The southern region is the most cement- rich region while other regions (northern, central, eastern, and western) have almost same cement production capacity.

The Indian cement industry is about 90 years old and its main sources of energy are thermal and electrical energy. The thermal energy is generally obtained from coal, and the electrical energy is obtained either from grid or captive power plants of the individual manufacturing units. In order to develop the guidelines for energy management policy for the sector, questionnaires were sent to nearly 100 cement plants. The questionnaires were framed in two parts, part A dealing with the quantitative details about the plant and part B covering the energy management practices followed by the plants. A total of 19 responses (nearly 20% response) were received from the plants. All the responses are from plants in the private sector. Three cement plants were also visited for detailed discussion with the plant personnel. The responses from the plants have been studied in detail and the analysis, separately for Part A and B, is given in the following paragraphs. Summary of the data collected from these plants is given in Annexure 4.1.

Salient features of Indian cement industry

- Indian cement industry is the 2nd largest in the world with an installed capacity of 135 MTPA. It accounts for nearly 6% of the world production.
- There are 124 large plants and around 365 mini plants. The industry presents a mixed picture with many new plants that employ state of the art dry process technology and a few old wet process plants having wet process kilns.
- Production from large plants (with capacity above 1 MTPA) account for 85% of the total production.
- The cement industry has achieved significant progress in terms of reducing the overall energy intensity.
- Based upon a survey that was conducted by NCCBM regarding the energy performance (2000-01) for various cement plants, it was found from the data analysis of 40 dry process plants that the weighted average thermal energy consumption was 734 kCal/kg clinker, and weighted average electrical energy consumption was 89 kWh/tonne of cement.*
- The best energy consumption figures reported by plants (that have responded to TERI's questionnaire) are 692 kCal/kg clinker and 66 kWh/ton of cement.

* *Source:*
Energy Performance Achievements in Indian Cement Industry, 2000-01, National Council for Cement & Building Materials, New Delhi

4.1 Analysis of Part A (Quantitative details) of questionnaire

The analysis of the questionnaires revealed that all the plants (except one) employ dry process. The energy intensity of the all the dry process plants (cost of energy as percentage of total production cost of packed cement) varies from 29 to 61% (see figure 4.1). This is observed to vary with the vintage of the plant, the technology employed by the plants and the type of cement produced.

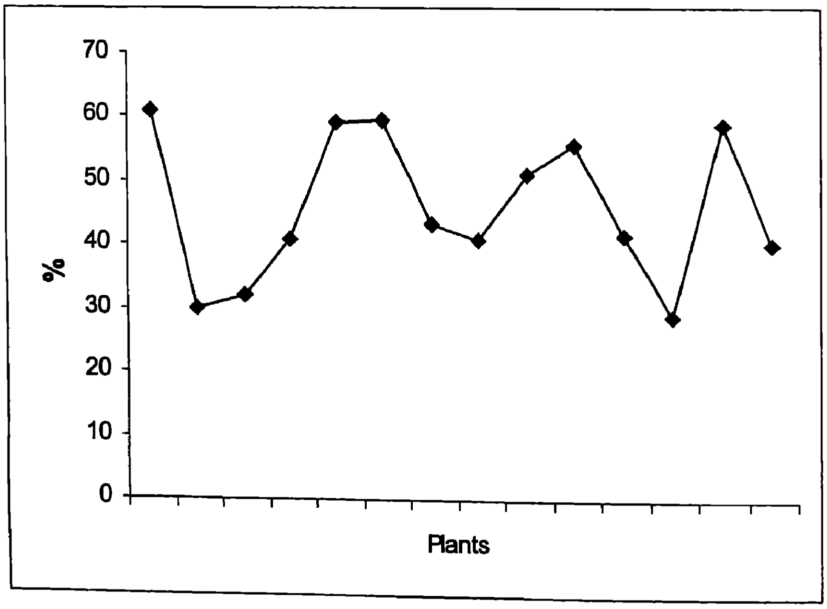


Figure 4.1 Energy cost as % of total manufacturing cost in different plants

Specific thermal and electrical energy consumption for the plants ranges between 692-879 kCal/kg of clinker and 66-127 kWh/ton of cement produced (product mix) respectively. The specific electrical energy also includes the energy consumed in packing, plant utilities and plant lighting. The reasons for wide range in specific energy consumption can be mainly attributed to the differing equipment configuration employed in different sections of the plants by various cement plants. For example, plants employing ball mills for grinding have reported higher specific electrical energy consumption as compared to plants having vertical roller mills. In addition, other factors like the plant capacity, its capacity utilization, vintage, product mix, process control system, maintenance aspects, raw material characteristics and above all the management's attitude and operational practices of plant personnel are also important. Besides, various external parameters like quality of coal, raw materials and power supply have their own repercussions.

Almost all the plants that have responded have a declining trend for specific electrical energy consumption over the last three years, which clearly brings out the fact that the industry is making efforts to improve its energy performance. However, in case of specific thermal energy consumption, 6 plants have reported an increasing trend over the last three years.

The vintage of the sample plants covered under the study ranges from 1968 to 1997.

The plants that expanded their capacity over a period of time have either more than one kiln commissioned in different years or upgraded the existing kilns in different years. A large number of plants have put up vertical roller mills for raw meal section. The balls mills are still operating in the clinker grinding and coal milling sections in some of the plants. Some of the newer plants have installed roller press and vertical roller mills in the clinker grinding section as well. Summary of the different equipment installed in different sections in the 19 plants is given in table 4.1a.

Twelve out of nineteen plants mentioned their energy conservation targets for next 5 years; only fifteen plants have energy targets for next 3 years. Details of the targets given by the responding units are given in table 4.1b. Almost all the plants provided brief details of the energy conservation measures implemented in past and measures planned to be implemented in near future. A brief summary of the energy conservation measures implemented by various plants is given in Annexure 4.2.

Table 4.1a Summary of different equipments installed in different sections in the plant

	Kiln section					Raw mill section			Coal mill section			Cement mill section	
Plant	K-W	K-DSP	PC	C-P	C-G	RM-BM	RM-VRM	RM-RP	CM-BM	CM-VRM	Cem-BM	Cem-VRM	Cem-RP
A	√				√	√			√		√		
B		√	√		√	√			√		√		
C		√	√		√		√			√		√	
D		√	√		√		√			√	√		√
E		√	√		√		√			√		√	
F		√	√		√	√	√			√	√		√
G		√	√	√	√	√	√		√		√		
H		√	√		√				√		√		

Plant	Kiln section					Raw mill section			Coal mill section			Cement mill section	
	K-W	K-DSP	PC	C-P	C-G	RM-BM	RM-VRM	RM-RP	CM-BM	CM-VRM	Cem-BM	Cem-VRM	Cem-RP
I		√	√		√		√			√	√		√
J		√	√		√		√			√	√		
K		√	√		√		√			√	√		√
L		√	√		√		√		√		√		
M		√	√		√	√			√		√		
N		√	√		√		√		√		√		
O		√	√		√	√		√	√	√	√		√
P		√	√		√		√		√		√	√	
Q		√	√		√	√			√		√		
R		√	√		√		√			√	√		
S		√	√			√	√				√		√

K-W: wet kiln; K-DSP: Dry kiln with suspension pre-heater; PC: precalcinator;
C-P: Planetary cooler; C-G: Grate cooler; VRM: vertical roller mill; RP: Role press;
BM: Ball mill; RM: Raw mill; CM: Coal mill; Cem: Cement mill

Table 4.1b Details of targets for reduction of specific energy consumption

	Electrical (kWh/t of cement)		Thermal (kcal/kg of clinker)	
	By 2004-05	By 2006-07	By 2004-05	By 2006-07
A	83	80	1250	1240
B	-	-	-	-
C	65	-	680	-
D	68	61	715	700
E	-	-	-	-
F	65	-	680	-
G	94	92	810	800
H	-	-	800	780
I	78	78	725	715
J	104	100	820	780
K	76	75	690	680
L	90	85	670	665
M	96	94	724	720
N	82	-	720	-
O	84	80	700	685
P	-	-	-	-
Q	95	90	775	770
R	78	76	700	698
S	95	92	1150	1140

4.1.1 International comparison of energy performance

The energy consumption in the cement plants varies widely in different countries depending upon a number of factors. Cement Manufacturers' Association (CMA) has compiled data of specific energy consumption for various South-East Asian countries and is given in Table 4.1.1.

Table 4.1.1 Specific energy consumption - international comparison (1999-2000)

Country	Electrical (kWh/t cement)	Thermal (kCal/kg clinker)
Japan	95	690
Korea	99	710
Taiwan	98	730
Thailand	103	720
India	105	750

Source. Cement Manufacturers' Association

Comparison of energy performance of Indian cement industry with other countries reveals that there exists scope for improving the energy performance of the Indian cement industry. Based upon the CMA data, the best reported energy performance figures in the world are 65 kWh/t of cement and 650 kCal/kg of clinker whereas the best in India is 69 kWh/t of cement and 665 kCal/kg of clinker. This clearly bring out the fact that although we have some of the best plants in the world in terms of energy performance, there are many plants where there exists scope for reducing energy consumption.

4.1.2 Norms for specific energy consumption

In the year 1999, National Council for Cement & Building Materials brought out NCB Guide Norms for Cement Plant Operations. The overall plant specific energy consumption norms as given in these guide norms are provided in table 4.1.2.

Table 4.1.2 Overall plant specific energy consumption norms

Type of plant	Electrical energy (kWh/t cement)	Thermal energy (kCal/kg clinker)'		
		4-st PH	5-st PH	6-st PH
Dry PC with VRM	85-95	760-800	740-760	720-740
Dry PC with Ball Mills	95-105	760-800	740-760	720-740
Dry SP	100-110	800-840	NA	NA
Wet	95-105		1250-1350	

4.2 Analysis of Part B (Energy management practices) of questionnaire

This section analyses the existing energy management practices followed by various plants and tries to summarize the findings for the cement industry sub-sector as a whole.

4.2.1 Structure of Energy Management Cell

Of the 19 responses, only 6 plants (30%) have energy management policy in place. On the other hand, around 90% of the plants have both quality and environment management policy and also displayed these policies publicly. Many of the companies have also got ISO certification.

The energy management is a critical focus of the top management for all cement plants. Most of the plants (85 %) have formal energy management cell (EMC) comprising of managers and engineers drawn from various departments. All the plants monitor energy consumption of each section of the plant on daily basis. The EMC of all the plants prepares reports on energy performance on daily and monthly as well as yearly basis. These reports are reviewed at different levels of management. The EMC recommends energy conservation measures, which are reviewed by various review committees internally within the plants. In almost all the plants, the top management takes final decision for implementation of short, medium and long-term energy conservation programmes. Modifications and retrofitting of energy efficiency equipment in different areas are implemented by respective heads of the departments with advise of top executives. There are 3 plants that don't have formal EMC in place. These plants also don't carry out energy audit regularly. A marked correlation between the energy performance and the presence of EM cell as well as frequency of energy audit of the plant was found. It was found from the data that the plants without formal EMC have higher values of specific energy consumption figures.

Fifty three percent of the plants have got energy audit conducted by both internal and external groups while thirty five percent of the plants conduct energy audit only internally. The frequency of external energy audit is longer as compared to internal energy audit. The frequency of energy audit is once in a year for almost 55% of the plants whereas 25 % of the plants favor only once in two years.

With regard to improving the performance of EMC, the following three suggestion were made by most of the respondents:

- A full time energy manager to head the EMC.
- The EMC should involve group head or chief executive in the energy reporting
- Separate budget commitment for energy management works.

The energy targets are set by majority of the plants by considering the best achieved in the past years and best energy figures in the region/sector.

4.2.2 Activities undertaken by plants to promote energy management

As per the responses received, majority of the plants organize training programmes for operators for awareness on energy conservation and specialized training programmes for officers who are directly monitoring energy consuming equipment. The EMC organizes presentation on energy management as well as presentation by external agencies on various energy conservation devices/techniques. There are various forums and campaigns, where the concept is promoted by way of giving awards and incentives to the employees. Suggestion scheme is also in place in most of the plants where the suggestions are received from all the levels in the plant for continuous improvement on reduced energy consumption levels. A summary of energy conservation measures implemented by various plants and their energy policy statements are given at Annexure 4.2 and 4.3 respectively.

All the responding plants have found high cost of technology as the severest constraint in implementation of energy conservation measures in the plant. However, fifty percent of the plants also felt the high interest rate as another main barrier. The plants view sharing of information through plant visits as a very important source of information and value the information provided by the associations through industry meets and technological database on energy efficiency.

Only 6 plants felt that the present government policies are conducive to promote energy management. With regard to the additional support needed from the Government, majority of the plants suggested reduction in customs and excise duties, and subsidies for energy conservation equipment, and R&D support to promote energy management as the possible options.

The top management's commitment is viewed as the most important point by all the plants, which should be stressed while framing the company's energy management policies.

4.2.3 Role of blended cements

From the national perspective, increasing the production of blended cements (pozzolanic and blast furnace slag cement) can be considered as one of the most effective means of reducing the energy intensity of cement production and at the same time conserving the scarce natural resources. Seventy percent (13 out of 19 plants) of the plants that have responded produce blended cements and have plans to further increase the production of blended cements. The plants that do not presently manufacture blended cements also have plans to manufacture blended cements in the near future. Analysis of the data for the last three years related to the quantity of the OPC and other blended cements produced by the responding cement plants clearly showed that the most of the plants that ventured into blended cements have increased the production levels of blended cements. The ratio of OPC to total cement produced is reducing and in some of the plants it is as low as 0.11, indicating very low level OPC production in comparison to other cements. This is a very encouraging trend and needs to be promoted. In order to further increase the use of blended cements, the plants have suggested a number of policy initiatives. Some of measures that have been suggested are:

- Promote use of blended cement in all Government projects/Government sponsored projects
- Incentives in the form of tax benefits should be given for manufacture of PPC /PSC.
- Awareness generation programs through seminars, technical workshops, interaction meets with architects/masons etc to promote usage of blended cements in smaller construction projects.
- Increased participation of the technical staff of cement plants/research organizations to educate and demonstrate the users about the benefits of blended cements.
- Grade wise categorization of blended cements so that the customers can chose as per their needs.

4.3 Field visits

Visits to three cement plants were undertaken under this project to interact with the plant management and understand their plans and policies with regard to their energy conservation policies. The three plants visited were:

1. Chettinad Cements Corporation Limited, Puliyur Works, Karur District, Tamilnadu
2. Madras Cements Limited, Alathiyur Works, Cement Nagar, Ariyalur District, Tamilnadu
3. The India Cements Limited, Dalavoi Works, Ariyalur District, Tamilnadu

All the three plants are dry process plants equipped with latest state of the art technologies. The plants have achieved significant progress with regard to improving their energy performance. In fact, one of the plants namely Madras Cements Limited is considered to be the most energy efficient cement plant in the world. Brief details of the plant and the discussions with the plant management are given in the following paragraphs.

4.3.1 Chettinad Cements

Chettinad Cements is a part of the Rs 10,000 million Chettinad Group which apart from cement, is also active in a host of other areas like shipping, engineering, information technology, textiles, etc. The two cement plants under the group are:

1. Puliyur Works – 1.0 million tonnes
2. Karikkali Works – 1.2 million tonnes

The plant is equipped with stacker/reclaimer, vertical roller mill (VRM) for raw meal, lignite and cement mill, a continuous blending silo and in-line calciner with 5 stage preheater. Some of the important milestones in the plant's progress since its commissioning are:

1989: Dry process kiln of 1700 tpd commissioned with VRM for fuel and limestone grinding

1994-96: 66 nos. of Wind electric generators installed (total capacity 17.3 MW)

1996: Stacker/reclaimer for limestone installed

1997: Bucket elevators for raw mill and kiln feed, impact crusher for limestone crushing, and bag filter for coal grinding installed

1998: VRM for cement mill and additional ESP for kiln/VRM circuit installed

1999: Kiln capacity increased to 2800 tpd, low pressure cyclones, and LV technology classifier in raw mill circuit installed

The incremental improvements undertaken by the plant in various sections by way of technology upgradation as mentioned above has helped the plant considerably in reducing its energy consumption. In addition, the plant has laid stress on production of Portland Pozzolana Cement (PPC), which has varied between 55 and 65% in the last three years, which has also contributed in reducing the overall energy intensity. The plant has drawn up plans to further increase the production of PPC and manufacture only PPC from next year onwards at its Puliyar Works. The decreasing trend in electrical and thermal energy consumption in the plant from 1998 to 2001 is shown in figures 4.3.1a and 4.3.1b. As can be seen, the specific energy consumption of the plant has reduced considerably from 102.6 kWh/ton of cement in the year 1998 to 76.31 kWh/ton of cement in the year 2001. The specific fuel consumption has also reduced from 775 kcal/kg of clinker in the year 1998 to 724 kcal/kg of clinker in the year 2001.

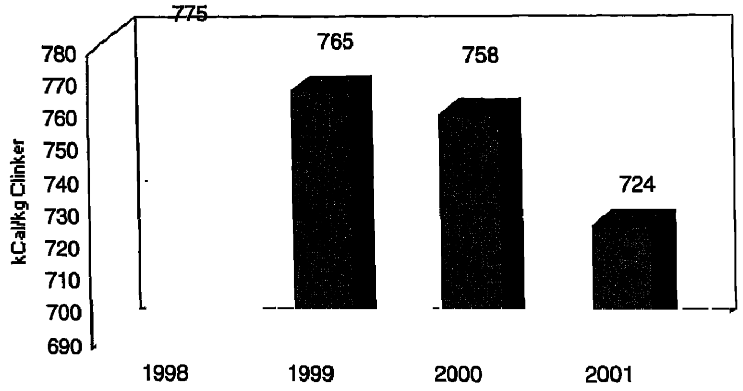


Figure 4.3.1a Chettinad Cement: specific thermal energy consumption from the year 1998-2001

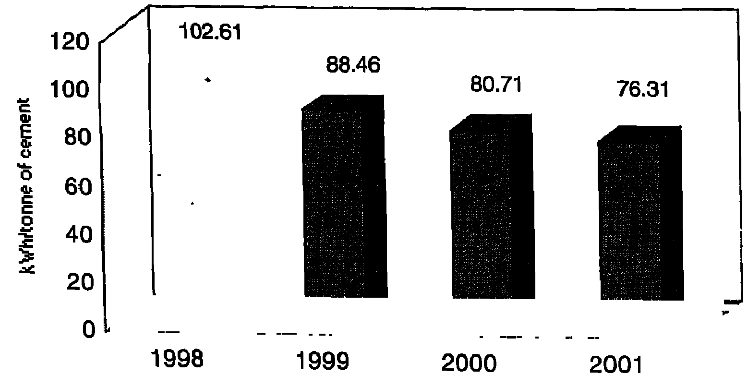


Figure 4.3.1b Chettinad Cement: specific electrical energy consumption from the year 1998-2001

4.3.1.1 Energy Policy

Apart from quality and environment policies, the plant has also formulated an energy management policy which has recently been formally adopted by the plant management. The policy states:

"Energy – Electrical, thermal, manpower – to monitor, improve and to sustain the achievements, fixing new targets to surpass the earlier results. We therefore strive

- To achieve lowest energy cost per unit of production
- To achieve to be the best energy efficient cement unit in India"

The unit has ISO 9002 certification while ISO 14001 certification is under implementation. CCCL is also recipient of Energy Conservation Award, 2001 administered by Ministry of Power, Government of India.

4.3.1.2 Energy conservation cell structure

To effectively monitor the energy consumption of the plant, an energy monitoring committee comprising of Chief General Manager, Energy Manager, Production Manager and Maintenance managers has been constituted. The role of the Energy Manager is to convene the meetings fortnightly, review the progress of implementation proposals and co-ordinate with the concerned departments for various activities related to implementation of energy conservation projects. In addition to Energy Management Cell (EMC), the company has established 8 Quality Circles. These groups also work for identifying new methods for achieving energy saving in their regular Quality Circle meets. The EMC meets twice in a month with specific agenda to review the progress of implementation of proposals. Respective heads of the departments implement the modifications and retrofitting of energy efficiency equipment in different areas.

The plant has energy monitoring system for all the operations, and energy consumption in various sections of plant is being monitored on a daily basis. The production department and energy conservation cell are responsible to maintain the records. Monitoring of section-wise power consumption is systematically evaluated with respect to target (achieved) by fixing clear responsibility of the individuals. The management also lays stress on employee motivation by encouraging them to participate in external programs related to energy efficiency and to publish in various journals.

4.3.1.3 Energy conservation budget and targets

To identify the potential areas for energy conservation, the plant gets energy audit done by reputed external agencies like CII and TERI once in two year.

Lately, the plant has undertaken two independent detailed audits for distinct areas where it was felt that there exists certain scope for improvement. These areas were compressor /blower audit and water audit. The plant has a separate budget for energy conservation purposes. The plant uses an internal system of setting energy consumption targets. These targets are decided on the basis of (1) last year's energy consumption and (2) best energy figures in the region/sector. The plant has identified various energy conservation schemes to be implemented in future, which can bring down the specific electric power consumption to 70 kWh/ton of cement.

4.3.1.4 Main issues for effective energy management policy

The plant felt that following issues were very important in helping the company reduce its energy consumption:

- Role of top management and its commitment towards energy conservation
- Regular energy audits to identify energy management opportunities
- Development of in-house capability for implementation of energy management projects
- Ushering in a culture of regular preventive and predictive maintenance
- Installation of energy efficient equipment

4.3.1.5 Policy initiatives to promote the use of blended cements in India

The plant has taken a number of pro-active measures to increase the demand of PPC in the region like regular organization of Mason Meets to educate them about the advantages of blended cements. As a result of these initiatives, the plant has been able to increase the production of PPC in the past few years. It is presently producing 65% of blended cement and has plans to increase it to 70% within the next few years. Regarding policy initiatives to promote the use of blended cement in India, the plant feels that Government should give some kind of incentive to cement industries for using fly ash, which is a waste material available in abundance in coal based thermal power plants.

4.3.2 Madras Cements

Madras Cements is part of the famous RAMCO Group with interests spanning a diverse range of activities like software, cement, ready mix concrete, cotton yarn, wind farms etc. Madras Cements Limited, a Rs 6000 million company, is South India's second largest company and has four manufacturing plants. The four plants are:

R R Nagar, Tamilnadu – 1850 TPD
Jayantipuram, Andhra Pradesh – 3200 TPD
Mathodu, Karnataka – 500 TPD
Alathiyur, Tamilnadu -6000 TPD

The first line of the Alathiyur plant was commissioned in 1997 with a capacity of 2200 tpd, which was upgraded to 2950 tpd in 1999. The second line with a capacity of 3000 tpd was commissioned in 2001. The plant has employed world class technologies like the surface miner, MMD crusher, covered stacker and reclaimer, VRMs, continuous flow silos, low pressure drop cyclones with inline calciner etc. The first SF Cross-bar cooler in India was commissioned at the second line, which results in optimised cooling and requires minimal maintenance. The reported specific energy consumption of this cooler is 5.2 kWh/tonne of material cooled as compared to 7.2 and above for other types of grate coolers. As a result of the state-of-the-art technology employed by the plant, it has very low levels of specific energy consumption. The reduction in specific thermal and electrical energy consumption achieved in the last four years in the plant is given in figures 4.3.2a and 4.3.2b. In 2000-01, the plant achieved the following energy consumption figures, which can be considered as the benchmarking figures for the nation.

Specific electrical energy consumption : 66 kWh/ton of cement
Specific thermal energy consumption : 700 kCal/kg clinker

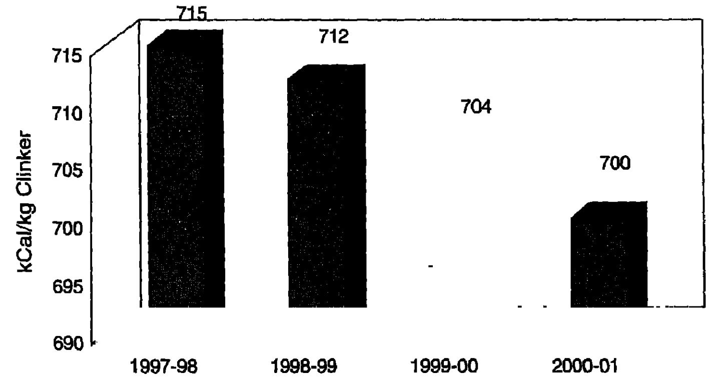


Figure 4.3.2a Madras Cement: specific thermal energy consumption from the year 1997-98 to 2000-01

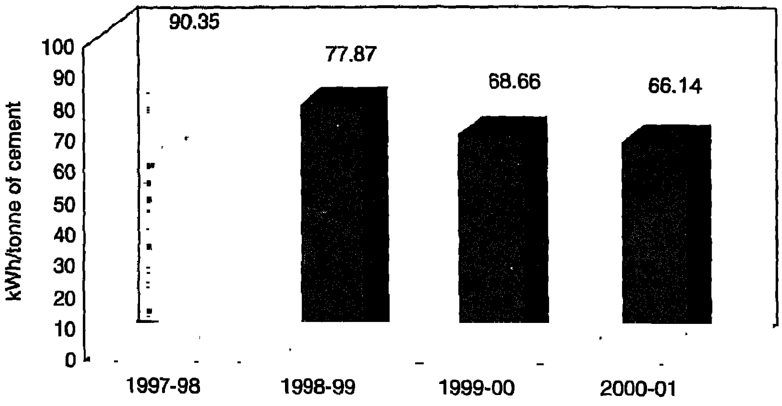


Figure 4.3.2b Madras Cement: specific electrical energy consumption from the year 1997-98 to 2000-01

The unique features of the Alathiyur plant that contribute to the plant efficiency and clean environment are:

- Entire mining is being done by Surface minor eliminating totally drilling, blasting, primary crushing and resulting in noise, vibration and dust free mining operations.
- New generation crusher for limestone crushing resulting in power requirement that is 60% less than the conventional crusher.
- Vertical Roller Mill for raw meal and coal grinding
- Specially designed low pressure drop cyclones for preheater and inline calciner
- Latest state of the cooler (CIS/CFG cooler) for clinker cooling
- Vertical Roller Mill for clinker grinding to achieve a superior product quality at minimum power consumption.
- Bucket elevators/belt conveyors to do all material conveying.
- Fuzzy logic software for continuous process efficiency/improvement.
- A specialised software for controlling the silos discharge for optimum raw meal. This will ensure minimum deviations.
- Variable speed drives for process fans.
- Use of a software for pre-blending for correcting limestone pile and to eliminate quality variations. This results in uniform quality of clinker, and consistent output which helps in more efficient running of equipment with less electric power and thermal energy consumption.

4.3.2.1 Energy conservation commitment, policy and set up

Company's top management has accorded a high priority to implement energy saving proposals as one of the major area of cost reduction. To achieve this goal, energy conservation cell headed by energy manager and supported by 7 executives in each department has been formed for continuous monitoring and control of energy conservation parameters (both thermal and electrical). The energy consumption reports are prepared on daily basis and analyzed on daily, weekly and monthly basis by the Energy Conservation Cell. Daily deviation from targets on each section is analyzed and compared with days of lower consumption levels. From this analysis, grey areas are located, examined and actions are immediately taken to bring back the desired levels. Such regular exercise always keeps the people alert and aware of the situation. Also it helps for continuous co-ordination between different functional areas. The specific responsibilities of energy manager include:

- Daily reporting and analysis of thermal and electrical energy consumption
- Collection of all energy conservation ideas/suggestions, studying their feasibility and submitting to top management
- Ensuring proper calibration of all relevant meters etc
- Creating awareness on energy conservation amongst plant personnel and motivating them to participate in suggestion schemes
- Arranging energy audits and implementation of follow up activities

The plant has also introduced suggestion scheme to motivate all employees for their involvement in energy conservation and to motivate their innovative skills. Quality Circles have also been introduced in all the departments.

The management takes special care to ensure that the metering is accurate. The energy meters are calibrated at least once in a year. The plant has continuous on-line monitoring of oxygen and carbon mono-oxide. Madras Cements has also taken initiatives to use petroleum coke as a fuel in a limited way. It is also manufacturing blended cements (mainly PPC) and has plans to increase its production.

4.3.2.2 Energy conservation awards

Madras Cements Ltd, Alathiyur unit was awarded for the best energy efficiency performance in Tamil Nadu. The award was given by CII – TNEB in 1999. It was also adjudged as the best energy efficient unit by Madurai Productivity

TERI LIBRA

Council in 1999. For the year 1999-00, it also bagged the best energy efficiency award from NCCBM.

4.3.3 India Cements

India Cements is also one of the largest and oldest cement manufacturing companies in India. The plant at Dalavoi was set up in 1997 with an installed capacity of 2500 tpd, which was later upgraded to 3600 tpd in 2001. With regard to energy efficiency, the company in its vision statement has stated:

"We shall aim to be the benchmark for the industry as energy efficient and thus conserve the energy and preserve the energy resources of our country for sustainable development"

An exclusive R&D division has been recently set up at Dalavoi unit to evolve new methods and solutions for the company in the field of energy conservation, product development, environmental control and customer services.

India Cements has also installed latest equipment like surface miner, hammer crusher, vertical roller mill for coal and raw meal grinding, low pressure cyclones and inline calciner, and combi-grinding with roll press for cement grinding. A process flow sheet for Dalavoi Works is given in Annexure 4.4. The plant has also taken various incremental steps to reduce its energy consumption during the past few years like optimisation in running of various equipment like recalciner, fans, raw mill, cement mill etc. As a result of these measures, the energy consumption has come down steadily over the past 4 years as depicted in figures 4.3.3.a and4.3.3b.

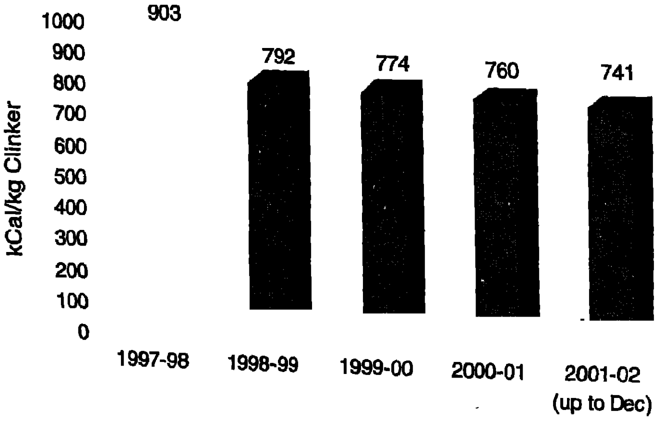


Figure 4.3.3a India Cements: specific thermal energy consumption from the year 1997-98 to 2001-02

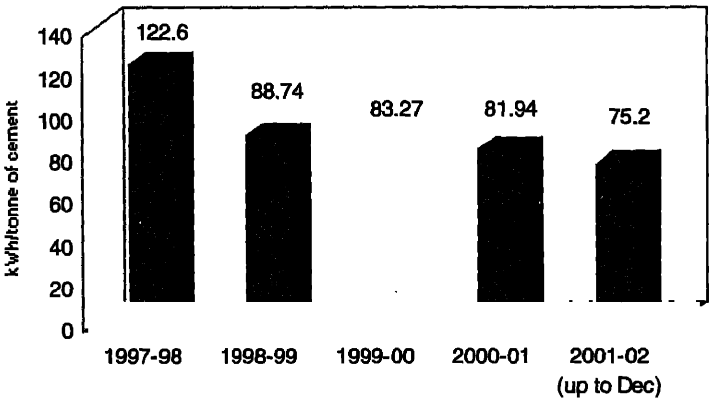


Figure 4.3.3b India Cements: specific electrical energy consumption from the year 1997-98 to 2001-02

4.3.3.1 Energy conservation cell structure

The company is deeply committed to energy conservation activities with the aim of improving its competitiveness and helping. The top management has set very clear targets for productivity, energy and plant availability, which are monitored and reviewed periodically. To meet the targets and goals, the plant has an Energy Audit Cell comprising of managers and executives. The members of the energy cell conduct weekly meeting to discuss about the energy conservation measures in different sections, the procedures to be followed for implementation, and the implementation schedule.

To motivate all employees, an energy saving suggestion scheme has been formulated to enable the employees to submit their suggestions. The EC members scrutinize all the suggestions and implementable suggestions are rewarded suitably. The suggestions are implemented by forming a team wherein the employee who has suggested is also a member in a team. Moreover, employees are motivated to present their suggestions in an audience of employees gathered every month for the Engineers' Meet. Thereby they feel their importance in the plant and also get self-confidence, motivation and team spirit.

The plant has also been very active in its approach with regard to production of blended cements. It has plans of increasing the production of blended cement production to 100% level.

4.4 Issues to be stressed while framing the energy policies of the cement industry

The cement industry in India has come a long way from a highly regulated regime during 1970s/80s to a now totally deregulated regime with the installed capacity of the industry increasing many-fold. A number of state-of-the-art plants have come up in the country. Some of the cement plants can even be counted amongst the most energy efficient and modern cement plants in the world. Many of the plants have taken steps to upgradate and modernise by adopting the latest technologies that have been developed by the international machinery manufacturers. The positive changes that are being witnessed in the cement industry as a result of the deregulation can be cited as a clear example of how energy efficiency within a plant is closely linked with the external environment.

Apart from achieving energy reduction through technological upgradation in plant and machinery, there are a number of softer approaches that need to be adopted to improve the energy performance at the plant level. The four most important points that have emerged from the analysis of the questionnaires and from direct interaction with the experts in this regard are highlighted below:

4.4.1 Top management commitment

Demonstration of commitment of the senior management staff is extremely important to ensure that the employees at the junior and operating level participate effectively in various activities related to energy management. Daily monitoring of section-wise energy consumption levels by the section heads and comparison with the set norms can give very positive signals to the operators of the importance being attached by the management to energy consumption. Deviation from the set targets should be analysed thoroughly and gray areas located so that corrective actions can be initiated.

4.4.2 Energy management cell (EMC)

One of the most important steps that needs to emphasized for energy intensive industries like cement is to have a dedicated energy management cell with a full-time energy manger responsible for overseeing its functioning. Apart from the regular activities of the EMC with regard to regular reporting and monitoring, the EMC must also be made responsible for imparting training to the junior plant personnel on energy management, initiating regular energy audits, and initiating and monitoring implementation of the recommendations of energy audits. This is all the more important now since cement sector is one of the designated consumers that has been identified for priority action under the Energy Conservation Act. It has also come out very clearly from the analysis of the responses from various cement plants that the plants not having a formal energy management cell with clearly defined roles have higher specific energy consumption.

4.4.3 Targets and budgets

Importance of having realistic short term and long term targets for reducing energy consumption was stressed during the field visits. Separate budgets must be earmarked on an annual basis for upgradation/modernization of plant and machinery (which is mainly a senior management decision) and for smaller incremental improvements.

4.4.4 Small group activities

Activities to involve the operators and foremen at the shop floor through small group activities like Quality Circles, suggestion schemes, and reward schemes should be encouraged in all the cement plants. Initiatives such as these can very helpful in creating awareness among the employees towards energy efficiency and resource conservation.

4.4.5 Production of blended cements

From a national perspective, increasing production of blended cements can be considered as one of the most effective means for reducing the energy intensity of cement production and at the same time conserving the scarce natural resources. Almost all the respondents to the questionnaires have acknowledged this fact and have stressed the need to promote manufacture of blended cements. The major barriers identified in this regard are lack of knowledge of consumers and lack of initiative on the part of both manufacturers and state/central government agencies in promoting blended cements. Some of the measures suggested by cement manufacturers to promote blended cements are:

- Policy focus and tax benefits to manufacturers to produce blended cements
- Incentives for using fly ash from thermal power stations along with clinkers for producing cement
- Educating the consumers on the usage of blended cements through seminars, technical workshops at national/regional levels and through small meetings (like mason meets) at the local level. The marketing

departments of cement manufactures and CMA can play a pro-active role in this direction.

- Increasing awareness among the general public through advertisements, electronic media, newspapers etc
- Categorization of blended cements (on the lines of OPC) like 30, 40, 50 and 60 Mpa grade so that customers can choose as per their needs.
- Promoting usage of PPC and PSC in large construction projects (Government funded as well as private sector projects).

Summary of the data collected from plants

Plant	Installed capacity - clinker (LTPA)			Number of kilns	Cement production (LTPA)			Specific thermal energy consumption (kcal/kg clinker)			Specific electrical energy consumption						Energy cost (Rs/tonne cement)			Energy cost (Rs/tonne cement)			Energy cost as a % of total production cost		
	2000-01	1999-00	1998-99		2000-01	1999-00	1998-99	2000-01	1999-00	1998-99	kWh/t clinker (till clinkerisation)			kWh/t cement produced (product mix basis)			Electrical			Thermal			2000-01	1999-00	1998-99
											2000-01	1999-00	1998-99	2000-01	1999-00	1998-99	2000-01	1999-00	1998-99	2000-01	1999-00	1998-99			
A	1.90	1.90	1.90	1	2.77	2.81	2.41	1268	1280	1312	57	58	63	86	88	95	186	189	204	416	414	456	30	30	32
B	3.73	3.72	3.30	1	3.40	3.20	3.07	871	838	790	90	85	73	127	123	11	252	186	133	303	264	256	61	59	56
C	5.61	5.61	5.61	1	7.77	8.28	8.33	724	758	765	58	61	62	76	81	88	307	283	290	285	251	290	30	29	32
D	8.25	8.25	8.25	1	10.06	10.45	9.78	760	774	792	58	57	60	82	83	89	NA	NA	NA	NA	NA	NA	NA	NA	NA
E	9.00	9.00	7.50	1	10.26	9.67	8.33	700	704	712	61	62	69	66	68	76	NA	NA	NA	NA	NA	NA	32	36	40
F	12.00	12.00	12.00	1	12.78	12.35	11.65	743	768	756	64	67	71	91	97	98	341	389	370	232	270	265	41	41	38
G	15.40	15.40	15.40	3	18.07	18.74	16.40	840	836	846	68	68	71	99	100	106	416	380	373	363	368	392	59	59	58
H	18.50	18.50	18.50	3	18.72	19.93	17.89	857	858	870	87	88	85	115	120	120	231	239	274	275	292	306	60	57	60
I	11.40	11.40	11.40	2	16.29	14.95	12.54	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
J	8.70	8.70	8.70	2	4.20	5.89	5.58	879	860	867	69	66	69	110	109	115	493	413	359	413	344	389	NA	NA	NA
K	19.00	19.00	19.00	2	21.36	23.12	20.44	707	707	731	58	52	53	78	74	78	331	293	318	194	259	268	41	48	42
L	7.50	7.50	7.50	1	6.52	6.39	6.86	692	680	684	67	67	68	98	100	107	408	357	365	208	229	221	51	52	49
M	8.00	8.00	8.00	1	7.71	7.48	5.78	745	746	761	76	79	82	105	108	114	408	358	359	238	253	256	56	55	53
N	22.11	22.11	22.11	3	17.50	18.27	15.71	743	725	740	52	52	57	89	90	96	NA	313	300	NA	264	303	NA	68	69
O	30.40	28.50	28.50	3	32.60	31.16	25.82	716	715	748	63	62	68	91	92	101	191	175	199	293	249	293	41	37	38
P	7.62	6.20	6.20	1	9.66	9.13	6.90	822	780	770	88	88	72	84	87	91	244	243	236	109	106	100	29	30	27
Q	6.00	6.00	6.00	1	6.19	7.67	7.60	837	855	823	75	78	79	107	110	109	324	331	310	347	308	279	59	59	64
R	15.50	15.50	15.50	1	18.22	16.50	14.00	703	714	737	48	49	54	80	84	92	276	279	304	273	240	273	40	36	37
S	3.42	3.42	3.42	2	2.52	2.41	2.13	1180	1213	1207	57	59	60	102	106	114	344	313	277	1178	1070	762	79	78	72

Note:

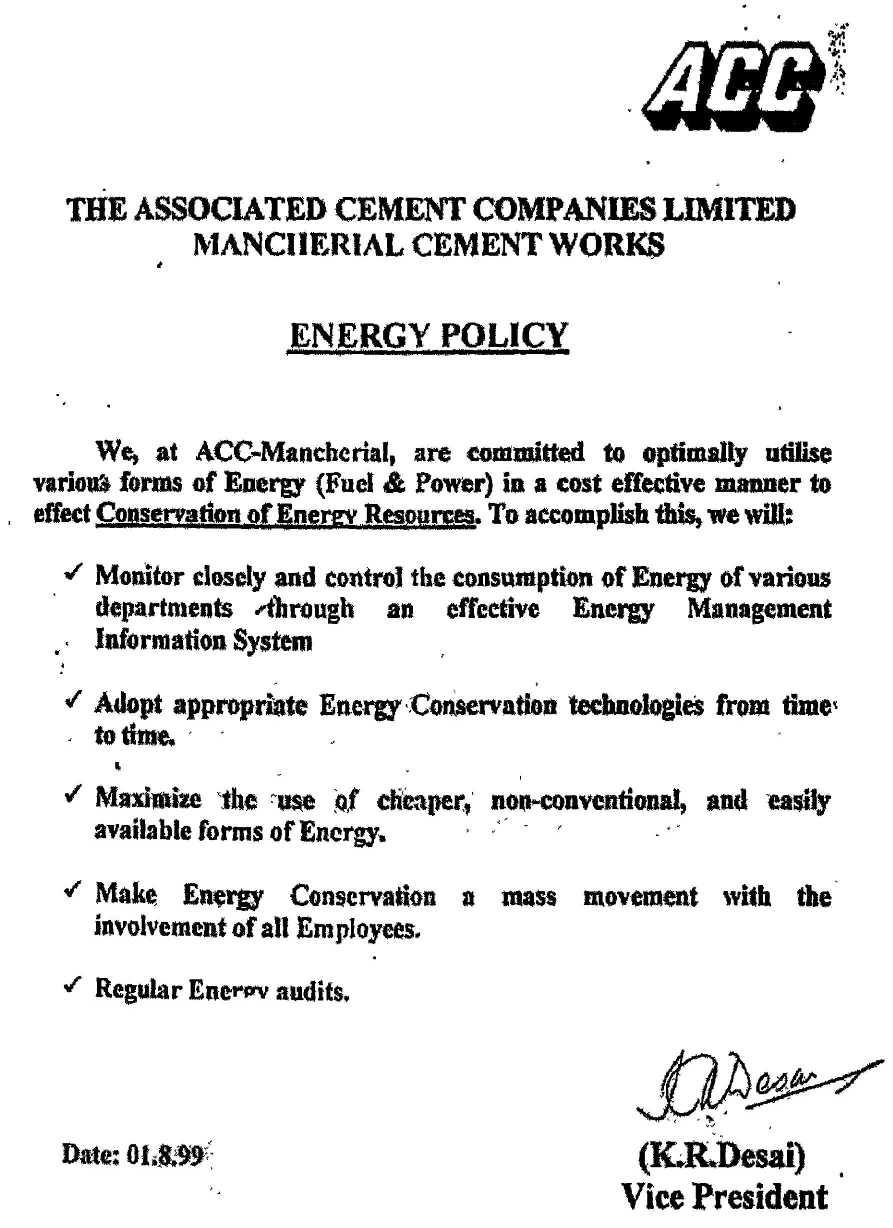
1 The specific electrical cosnumption on a product mix basis includes packing, plant utilities, lighting but excludes colony lighting

2 NA. Not available

Summary of energy conservation measures implemented by various plants

- Optimization of grinding mills and upgradation of the grinding circuit
- Use of Vertical roller mills and roller press
- Use of high efficiency classifiers
- Increased manufacture of blended cements
- Installation of low pressure drop cyclones and other modifications in the preheater circuit
- Duct modifications to reduce pressure loss
- Waste heat utilization from cooler vent
- Arresting false air leakage in the kiln system
- Arresting air leakage in compressor circuit
- Use of FRP blades in cooling towers
- Optimize operation of various energy consuming equipment and avoiding idle running of equipment
- Plant lighting optimization
- Optimization and use of high efficiency of fans and using Variable speed drives
- Use of flat belts in place of V belts
- Slip power recovery system
- Improving distribution voltage co-ordination and power factor improvement to reduce distribution losses
- Blending silo upgradation
- Use of better quality refractories
- Use of mechanical conveying systems (bucket elevators)
- Retrofitting of cooler
- Dense phase conveying
- Optimization of cement mill with changes in internals
- Clinker cooler hammer mill modifications
- Use of slurry thinners
- Fuzzy logic control
- Installation of mechanical seals in kilns

Energy policies



THE ASSOCIATED CEMENT COMPANIES LIMITED
MANCHERIAL CEMENT WORKS

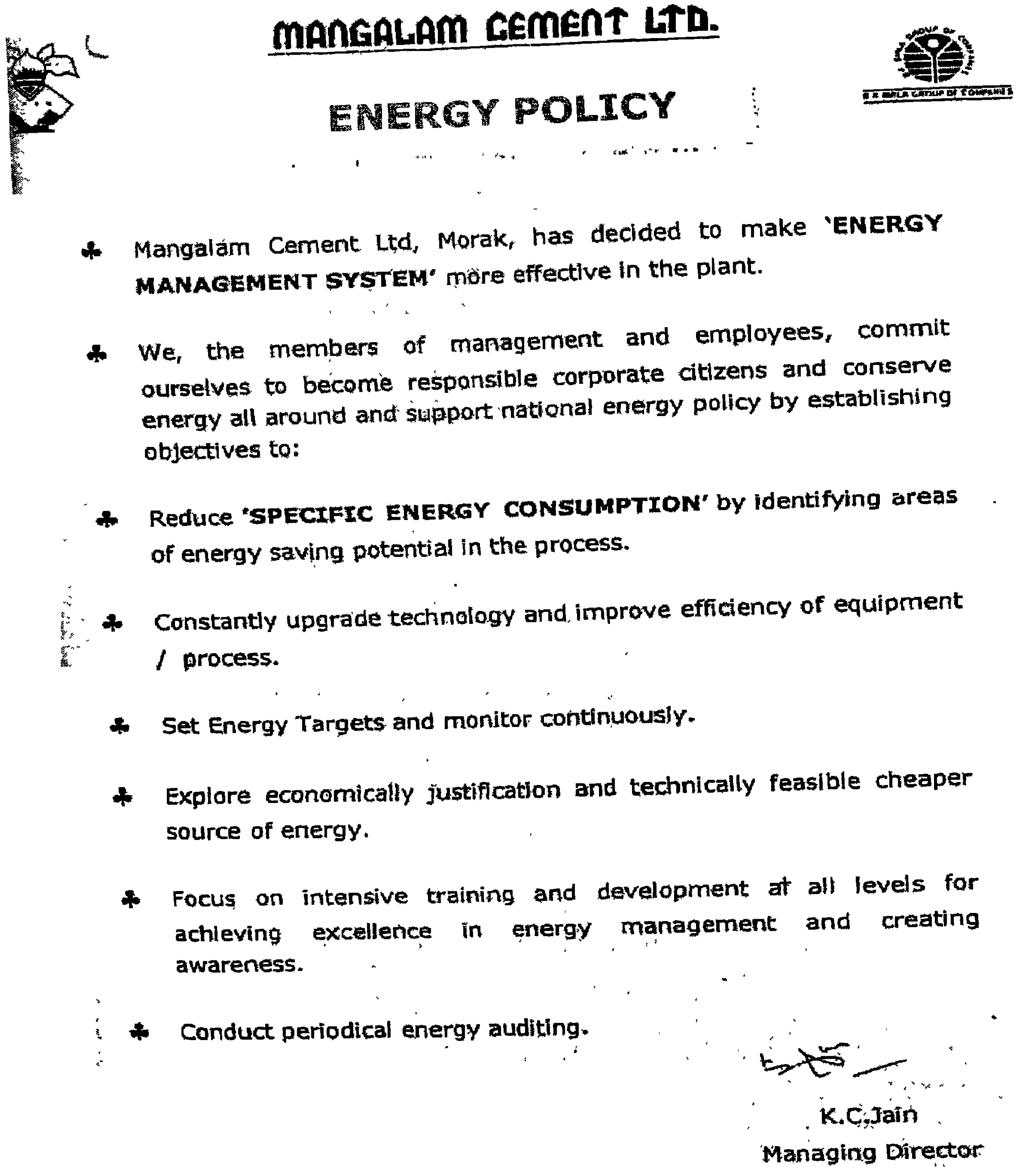
ENERGY POLICY

We, at ACC-Mancherial, are committed to optimally utilise various forms of Energy (Fuel & Power) in a cost effective manner to effect Conservation of Energy Resources. To accomplish this, we will:

- ✓ **Monitor closely and control the consumption of Energy of various departments through an effective Energy Management Information System**
- ✓ **Adopt appropriate Energy Conservation technologies from time to time.**
- ✓ **Maximize the use of cheaper, non-conventional, and easily available forms of Energy.**
- ✓ **Make Energy Conservation a mass movement with the involvement of all Employees.**
- ✓ **Regular Energy audits.**

Date: 01.8.99

(K.R.Desai)
Vice President

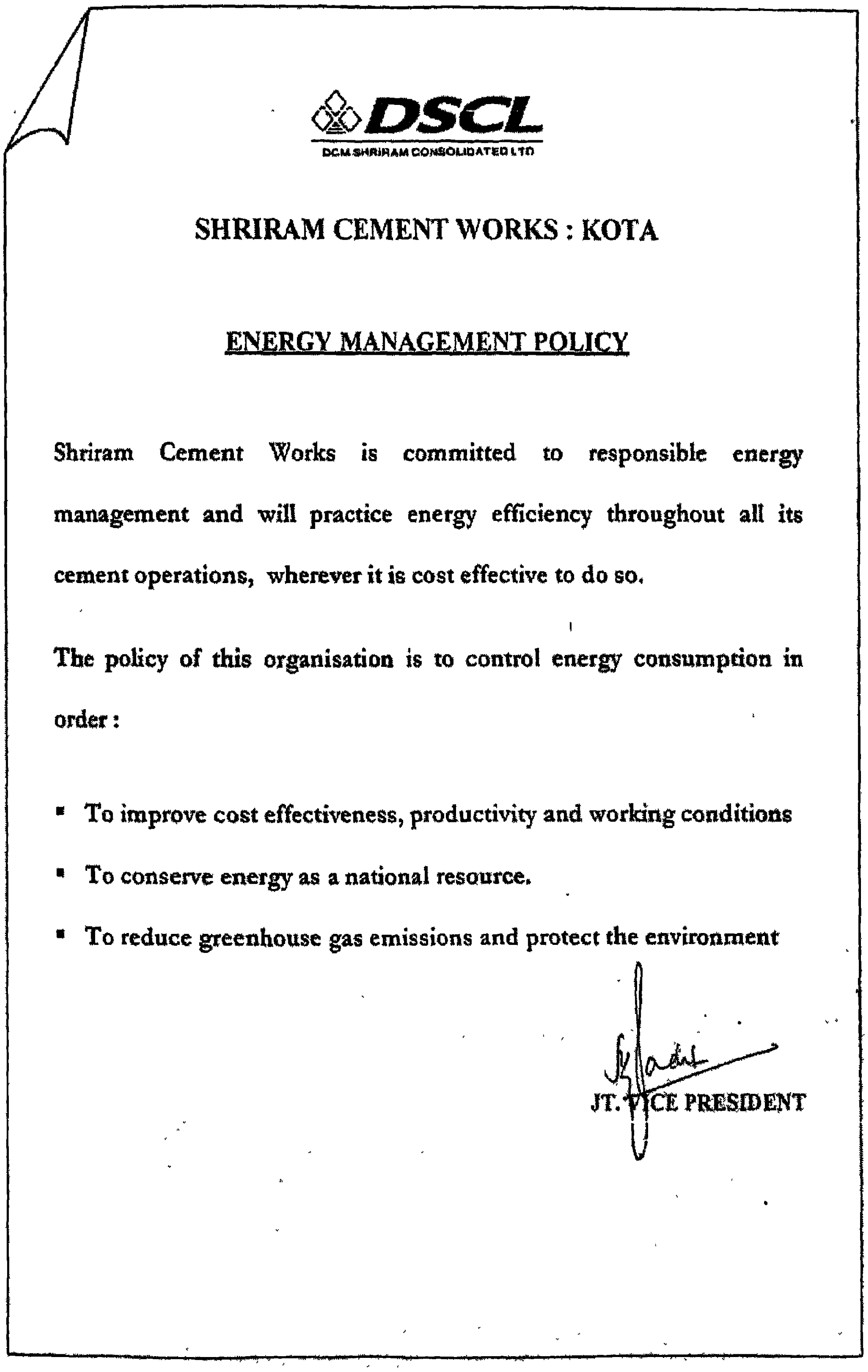


MANGALAM CEMENT LTD.

ENERGY POLICY

- Mangalam Cement Ltd, Morak, has decided to make **'ENERGY MANAGEMENT SYSTEM'** more effective in the plant.
- We, the members of management and employees, commit ourselves to become responsible corporate citizens and conserve energy all around and support national energy policy by establishing objectives to:
- Reduce **'SPECIFIC ENERGY CONSUMPTION'** by identifying areas of energy saving potential in the process.
- Constantly upgrade technology and improve efficiency of equipment / process.
- Set Energy Targets and monitor continuously.
- Explore economically justification and technically feasible cheaper source of energy.
- Focus on intensive training and development at all levels for achieving excellence in energy management and creating awareness.
- Conduct periodical energy auditing.

K.C.Jain
Managing Director



DSCL
DCM SHRIRAM CONSOLIDATED LTD

SHRIRAM CEMENT WORKS : KOTA

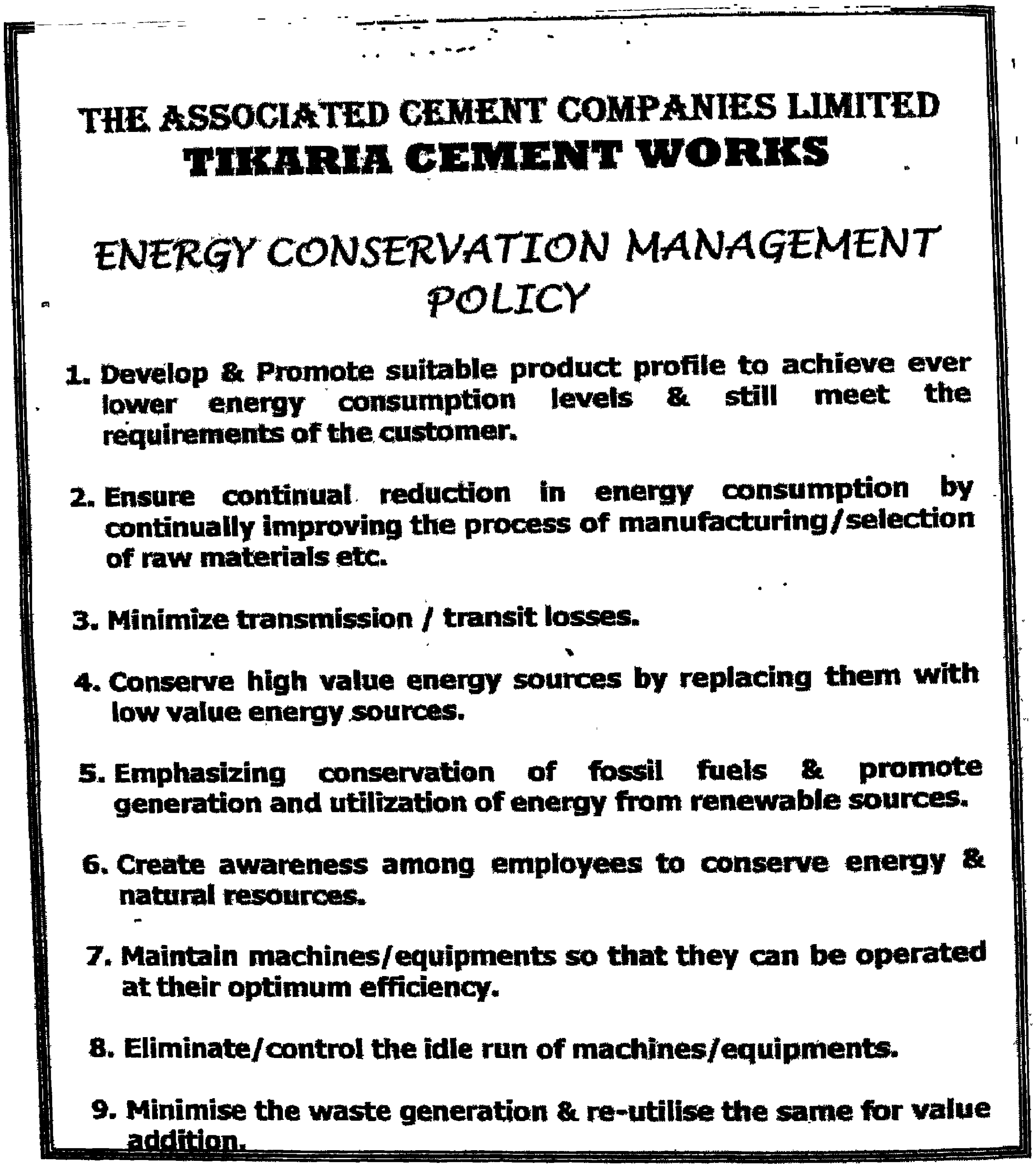
ENERGY MANAGEMENT POLICY

Shriram Cement Works is committed to responsible energy management and will practice energy efficiency throughout all its cement operations, wherever it is cost effective to do so.

The policy of this organisation is to control energy consumption in order :

- To improve cost effectiveness, productivity and working conditions
- To conserve energy as a national resource.
- To reduce greenhouse gas emissions and protect the environment

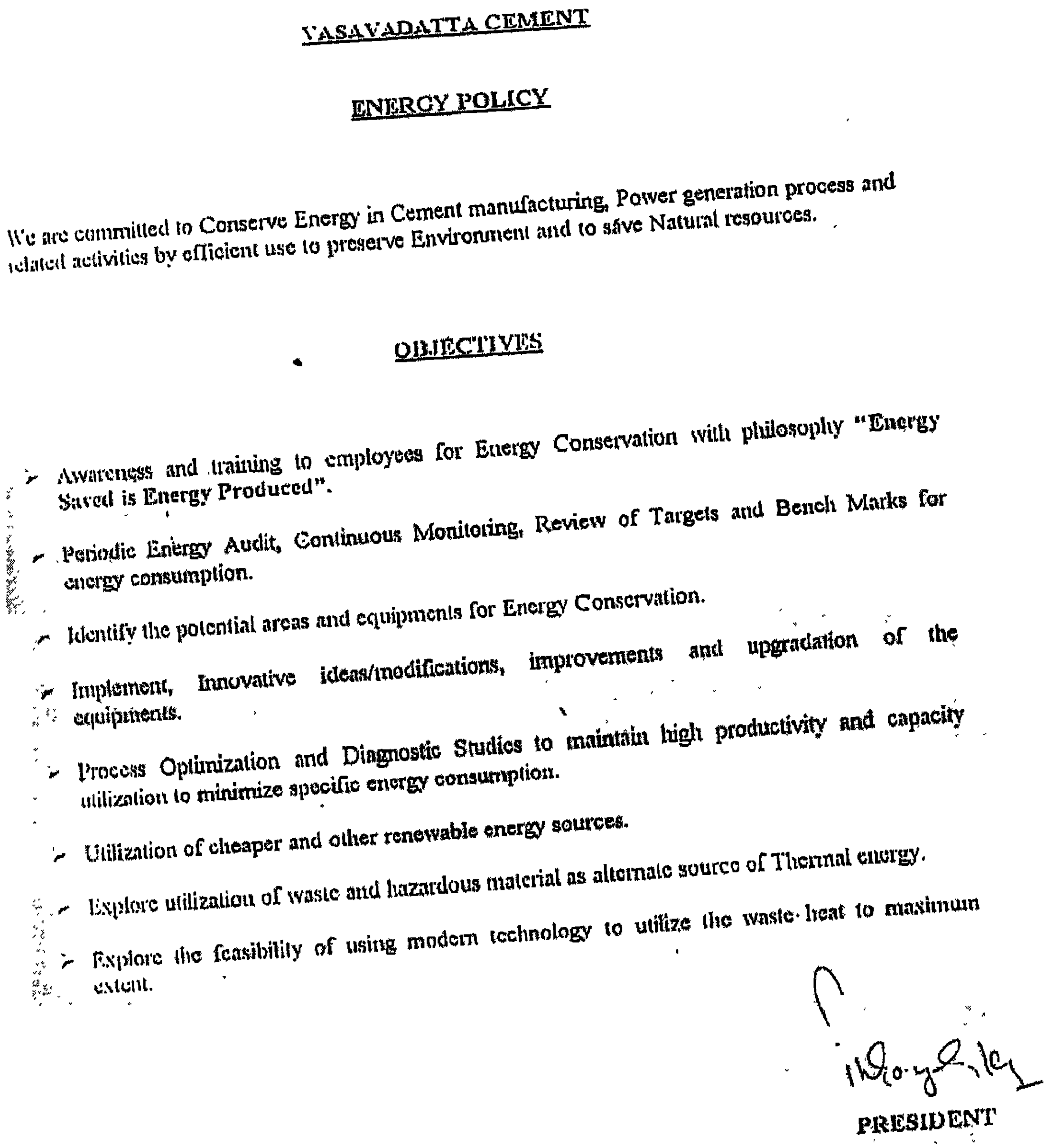
JT. VICE PRESIDENT



THE ASSOCIATED CEMENT COMPANIES LIMITED
TIKARIA CEMENT WORKS

ENERGY CONSERVATION MANAGEMENT POLICY

1. Develop & Promote suitable product profile to achieve ever lower energy consumption levels & still meet the requirements of the customer.
2. Ensure continual reduction in energy consumption by continually improving the process of manufacturing/selection of raw materials etc.
3. Minimize transmission / transit losses.
4. Conserve high value energy sources by replacing them with low value energy sources.
5. Emphasizing conservation of fossil fuels & promote generation and utilization of energy from renewable sources.
6. Create awareness among employees to conserve energy & natural resources.
7. Maintain machines/equipments so that they can be operated at their optimum efficiency.
8. Eliminate/control the idle run of machines/equipments.
9. Minimise the waste generation & re-utilise the same for value addition.



YASAVADATTA CEMENT

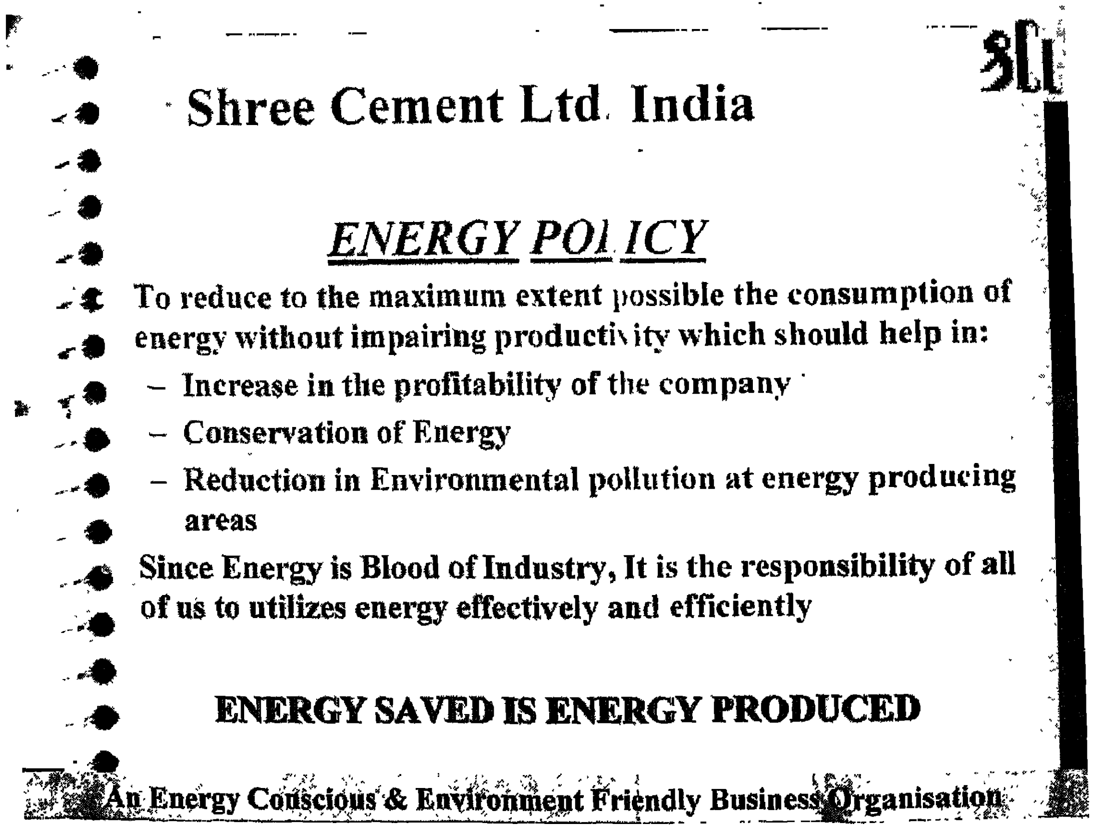
ENERGY POLICY

We are committed to Conserve Energy in Cement manufacturing, Power generation process and related activities by efficient use to preserve Environment and to save Natural resources.

OBJECTIVES

- Awareness and training to employees for Energy Conservation with philosophy "Energy Saved is Energy Produced".
- Periodic Energy Audit, Continuous Monitoring, Review of Targets and Bench Marks for energy consumption.
- Identify the potential areas and equipments for Energy Conservation.
- Implement, Innovative ideas/modifications, improvements and upgradation of the equipments.
- Process Optimization and Diagnostic Studies to maintain high productivity and capacity utilization to minimize specific energy consumption.
- Utilization of cheaper and other renewable energy sources.
- Explore utilization of waste and hazardous material as alternate source of Thermal energy.
- Explore the feasibility of using modern technology to utilize the waste heat to maximum extent.

PRESIDENT



Shree Cement Ltd. India

ENERGY POLICY

To reduce to the maximum extent possible the consumption of energy without impairing productivity which should help in:

- Increase in the profitability of the company
- Conservation of Energy
- Reduction in Environmental pollution at energy producing areas

Since Energy is Blood of Industry, It is the responsibility of all of us to utilizes energy effectively and efficiently

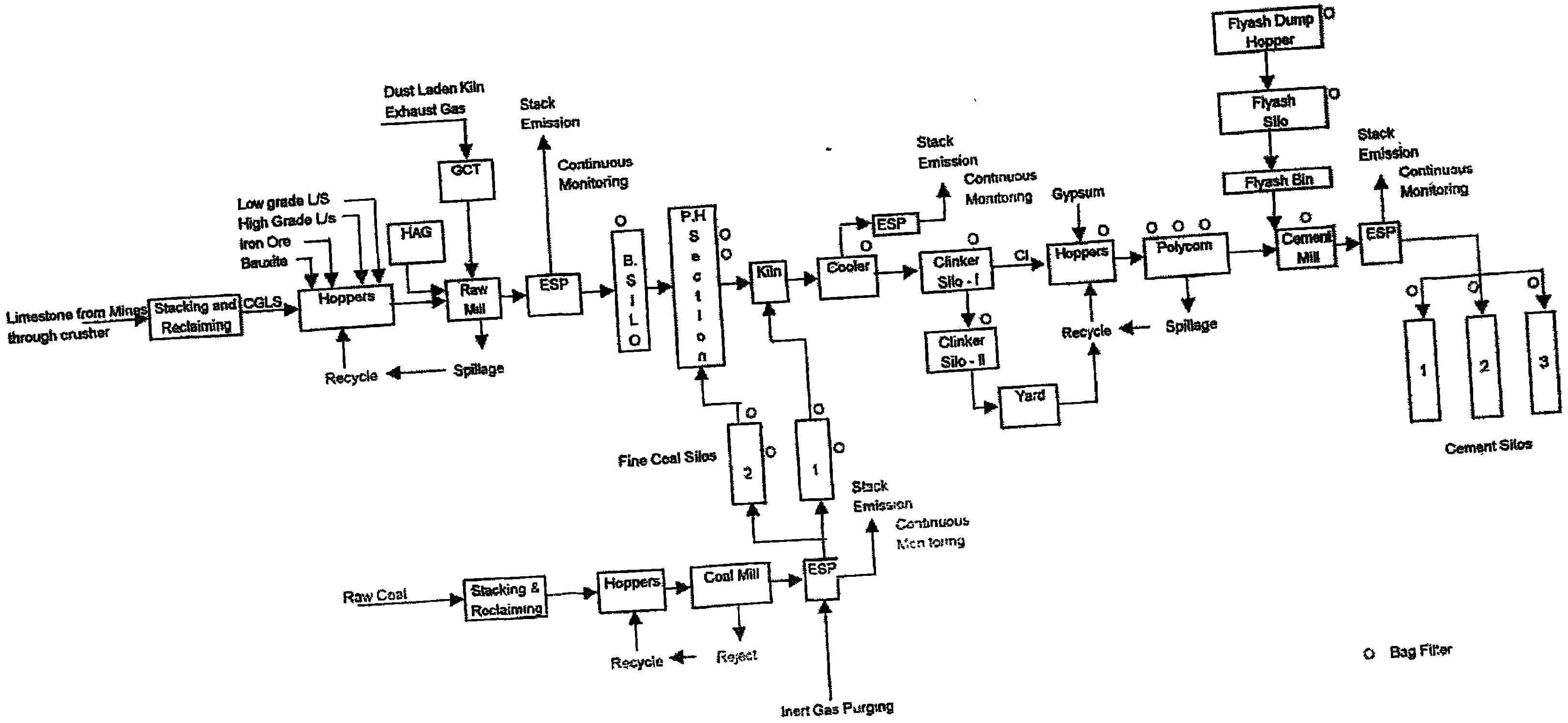
ENERGY SAVED IS ENERGY PRODUCED

An Energy Conscious & Environment Friendly Business Organisation

Process flow sheet for India Cements Ltd, Dalavoi

THE INDIA CEMENTS LIMITED - DALAVOI

PROCESS FLOW CHART



5

Fertilizer Industry

5.1 Background

Fertilizer sector is very crucial for Indian economy because it provides a very important input to agriculture. Moreover the fertilizer industry, specially the ammonia-urea plants, are highly energy intensive in their operation. This study has focused on integrated ammonia-urea fertilizer complexes in the country.

There is wide variation in the vintage of fertilizer plants in the country. The oldest fertilizer plant belonging to the vintage of 1960s. In terms of feedstock, major feedstocks presently being used in the fertilizer plant are natural gas, naphtha, and fuel oil/LSHS.

Over the years, the majority of industry has improved its performance significantly in terms of specific energy consumption and capacity utilization. There are several state-of-the-art fertilizer plants operating in India. There are around 27 fertilizer plants[a] in the country engaged in the manufacture of urea. Twenty-one separate corporate groups own these 27 fertilizer plants. Out of 21 companies, 12 belong to private sector, 7 to public sector and 2 to cooperative sector. In terms of total installed capacity of urea in the country, the ownership among private, public and cooperative sectors is given in figure 5.1.

Under this initiative, around 40 questionnaires were sent to various fertilizer plants and their corporate offices to collect relevant information. Total ten responses were received from the plants in form of filled questionnaire and through plant visits, representing a response rate of 25%. List of plants that provided feedback for the study include:

1. IFFCO, Kalol
2. IFFCO, Phulpur
3. KRIBHCO, Hazira
4. NFL, Bhatinda

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ld and expansion plants are treated as one plant only.

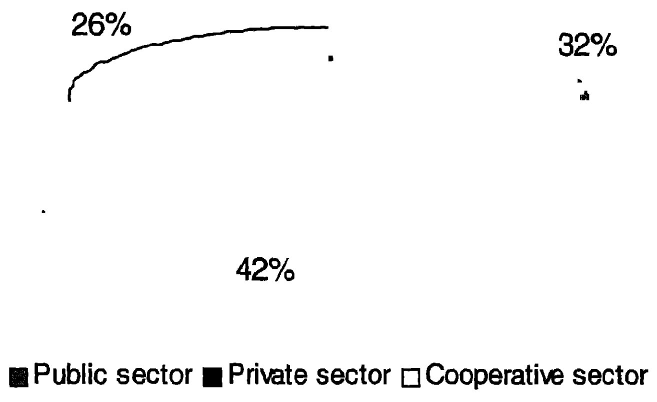


Figure 5.1 Distribution of installed capacity among different sectors

Salient features of Indian fertilizer industry

- Fertilizer sector is very crucial to Indian economy, provides important input to agriculture sector. It is regulated by government policies administering the price of fertiliser and the production.
- Twenty-one separate corporate groups own 27 plants (old and expansion plant treated as one)
- Urea production is energy intensive process
- Natural gas, naphtha, LSLS/fuel oil are used as feedstock for producing urea
- Cost of energy varies from 65% to 87% of production costs.
- Specific energy consumption of sample plants covered under this study varies between 5.53 GCal/MT of urea and 10.2 GCal/MT.
- Majority of industry is energy conscious and focuses on energy management.

  However, only one plant has a declared energy management policy
- Over the years, the industry has improved its energy performance by bringing down the specific energy consumption and improving capacity utilisation

5. FACT, Cochin
6. RCF, Thal
7. Tata Chemicals, Babrala
8. Zuari Industries Limited, Goa
9. Chambal Fertilizers and Chemicals Ltd., Kota
10. Shriram Fertilizers and Chemicals Ltd., Kota

Among the plants listed above, 4 are in private sector, 3 are in public sector, and 3 are in cooperative sector. Vintage of the sample plants covered under the study range from 1969 to 1999. Out of the sample plants, 1 plant was commissioned in 1960s and 3 plants each were commissioned during 1970s, 1980s, and 1990s. Only two expansion plants were commissioned during 1990s. In terms of feedstock, 4 plants are based on naphtha, 5 on natural gas and 1 on fuel oil. The expansion plant at Chambal Fertilizers and Chemicals has changed the feedstock, and is now based on naphtha. In all other expansion plants at the same site, the feedstock is same as the original plant.

5.2 Analysis of Part A (Quantitative details) of questionnaire

As mentioned earlier, urea plants are very energy intensive and therefore cost of energy is the most critical factor in cost of production. Among the plants that took part in this study, the cost of energy varies from 65% to 87% of production. Production of ammonia is the most energy intensive process and accounts for around 80% of total energy consumption.

Specific energy consumption of sample plants covered in this study ranges from 5.37 GCal/MT of urea to 10.2 GCal/MT of urea. The wide range of specific energy consumption per tonne of urea can be explained by factors related to feedstock/fuel used and vintage of technology. Analysis of data shows that new generation plants commissioned recently use state-of-the-art technology and are therefore more energy efficient compared to the older generation plants. Similarly, type of feedstock/fuel used also has bearing on the specific energy consumption. For fertilizer manufacturing natural gas is most preferred and efficient feedstock. This explains the fact that specific energy consumption of all gas based plants is lower than that of plants based on other heavier feedstock/fuels. Discussions with industry personnel during field visits highlighted that for naphtha-based plants in the country, the specific energy consumption of plants commissioned recently is significantly lower than that of older plants commissioned during 1960s and 1970s.

For the sample plants, the overall trend of specific energy consumption over the years has been declining. Even the old plants have improved their specific energy consumption over the years through revamp/retrofits and continuous investments towards reducing energy consumption. Summary of plant data on specific energy consumption, capacity utilization and installed capacity is given in Annexure 5.1.

Eight out of twelve plants that responded to the questionnaire mentioned about their energy conservation targets for next 5 years. All the plants mentioned some details about the projects being implemented by the plant in past. However, only a few plants mentioned in detail about various energy conservation options to be adopted the future. The details specified by various plants included information on major energy conservation options that were planned for implementation in near future. Table 5.2 gives details of selected energy efficiency and energy conservation measures adopted by the plants in past three years.

Table 5.2 Selected energy conservation measures implemented

S.No.	Measure implemented by the plants
Process measures	
1.	Additional coils in the convection section of furnaces
2.	Cooling water booster pump and CO_2 bypass line for CO_2 final cooler
3.	Line size increase of Cold Shot Line to ammonia converter
4.	CO_2 compressor revamp
5.	Replacement of urea stripper by bi-metallic strippers
6.	Modification in rotor of CO_2 centrifugal compressor
7.	Heat recovery from LP steam condensate by CO_2 compressor turbine surface condensate
8.	Isolation of NG booster compressor gland ejector
9.	Stoppage of motor driven surface condensate pump with single pump operation
11.	Replacement of MP steam header of boiler feed water pump
Utility	
1.	Replacement of steam trap with condensate pot level control valve arrangement
2.	Air compressor speed reduction from 6550 to 6450 rpm
3.	Cold insulation replacement
4.	Modification for reduction in liquid effluent generation
5.	Installation of additional economizer parallel to existing economizer to reduce F.E. pressure drop
6	Replacement of old pump with new pump
7	Variable frequency drive for feedstock pumps
8.	Regular preventive maintenance works, boiler tube cleaning during ATR etc. have resulted in higher on-stream factor and minimize energy loss

5.3 Analysis of Part B (Energy management practices) of questionnaire

Part B of the questionnaire deals with qualitative details about various policy initiatives and energy conservation measures taken by the plant to improve energy efficiency in long-term. The questionnaire draws information on various aspects of energy conservation, which are classified under the following broad head:

- Certification/ declared policies with regard to energy efficiency, quality and environment

- Company's commitment to energy management
- Energy management cell: organization and functionality
- Activities undertaken by the company to promote energy management
- Budget for energy conservation and investment decisions
- Role of industry association and peer group
- Barriers to implementation of energy conservation measures
- Government policies and sectoral policies
- Energy management policy

The consolidated information from the questionnaires is presented below. Analysis of qualitative information will help in determining the impetus on energy management by various companies that have responded to the questionnaire.

5.3.1 Policies and certifications

The response to the questionnaire is given in figure 5.3.1. Out of the responses received, only one plant had clearly defined energy management policy (Annexure 5.2). One plant (covered under the field visit) was actively engaged in formulation of energy management policy at corporate level. Other eight respondents did not have any formal energy management policy in place. However, as mentioned earlier, energy efficiency is always a critical focus of management in all fertilizer units.

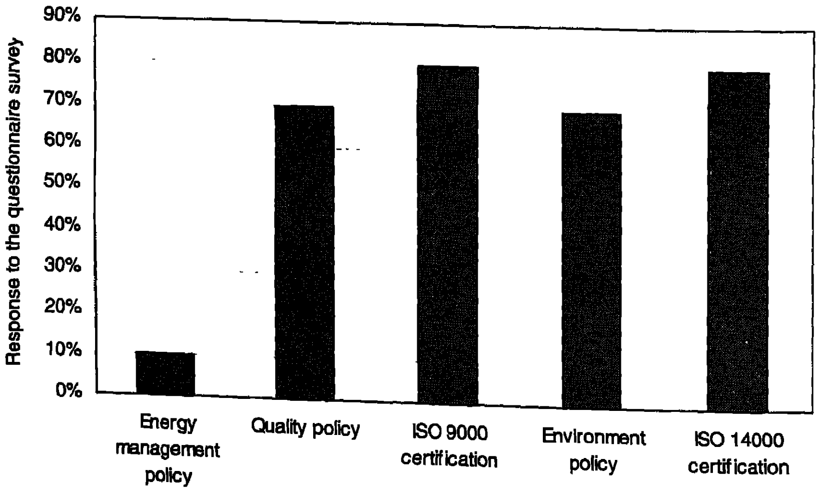


Figure 5.3.1

On environment management, only 7 plants have declared environment policy that is publicly displayed. Three plants do not have any declared environment policy. With regard to ISO 14000 certification, 8 plants reported having acquired the certification.

Seven plants have in place quality policies that are publicly displayed. Eight out of ten respondents reported having ISO 9002 certification for their respective manufacturing facilities.

5.3.2 Commitment to energy management

In all the cases, the response reported that energy management is critical focus of the top management. Given the fact that manufacturing of urea is energy intensive, it is imperative that energy management will be top priority for the management. However, not all the plants have a well-defined energy management policy in place.

Only in the case of four respondents the annual reports carry a detailed mention of energy management policy and various initiatives/projects undertaken by the plant. For other six plants, the annual reports discuss energy management but not in detail. During the survey, six respondents mentioned that energy management policies are decided based on a cross-functional approach involving all levels of management. In rest of the four sample plants, senior level management drawn from different departments decides energy management policies.

In only two plants, there is a member in the management board with specific responsibility related to energy management. All the sample plants covered under the survey make action plans for energy management, however, in only eight plants the energy management plans are drawn up in advance on yearly basis. In rest two plants, energy conservation projects are drawn on an "as required" basis.

Given higher energy intensity of fertilizer plants and given the fact that cost of energy forms a large part of the total production cost, daily reporting of energy parameters is carried out in majority of plants. Only in two plants energy reporting was carried out on a weekly basis. The reporting of energy parameters is done to all management levels in the company. As a fallout of all this, the interaction between EM Cell (or equivalent organization set-up) and top management is frequent in all plants covered in the survey.

5.3.3 Energy management (EM) cell

All the plants covered in the survey and during the field visits have a department that has same/extended job responsibilities as that of an EM Cell. In majority of fertilizer plants, the equivalent organizational set-up is in the form of "Technical Services (TS)" department that performs the duties of a typical EM Cell. Organization chart of a typical TS department is provided in Figure 5.3.3. Additionally, the TS departments perform the role of troubleshooting, preventive and predictive maintenance, plant/process modifications etc. Mostly these departments are cross-functional in nature and consist of multi-disciplinary team of professionals. The key personnel of this department frequently meet frequently the top management and discuss the energy-related issues. As reported by the sample plants, major job responsibilities of the EM Cell consist of:

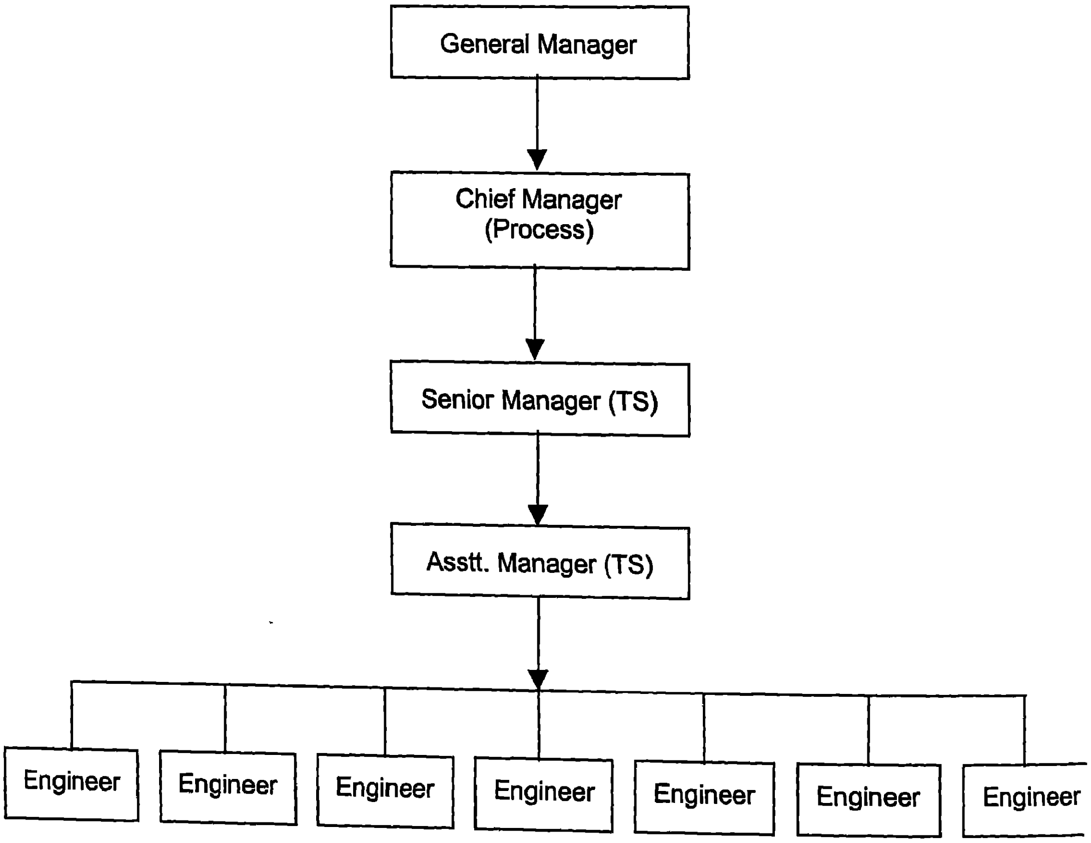


Figure 5.3.3 Structure of a typical "Technical Services" Department

- Identification of energy conservation projects
- Execution of energy conservation projects in the plant
- Continuous monitoring of energy performance of plant and equipment
- Prepare energy consumption status report for review by different levels of management
- Interact (formally and informally) with different departments in the plant and motivate them to conserve energy

With regard to improving the effectiveness of EM Cell, most respondents felt that appointment of a full time energy manager would certainly give thrust to energy conservation at plant level.

Second most important thing that is required to improve the performance of the EM Cell is to make budgetary commitment for energy management at corporate level. It is inferred that having a separate budget for energy conservation will certainly show more commitment from top management towards energy management in the plant.

5.3.4 Activities undertaken to promote energy management

One of the indicators of promoting innovation for energy management is organization of small group activities in the plant. Sixty percent of the plants responded that they undertake small group activities with relevance to energy conservation (where energy conservation is a part of productivity and efficiency). These plants can be considered proactive as they have taken initiatives to inculcate the practice of small group activities in the plant. However, in only 3 plants the small group activity is undertaken at shop floor level. In other three units the exercise is conducted at the level of middle management. In only one of the six plants the small group activities are organized for all management levels.

With regard to carrying out energy audits, five plants favour both internal and external energy audit for identifying energy conservation areas. Two plants mentioned about carrying out only internal energy audits. The fact that most of the units conduct internal energy audit reflects their technical capacity to undertake energy audits. During discussion with the industry personnel and the industry association, it was brought out that most units in the fertilizer industry are technically competent for carrying out such assignments. The frequency of energy audit varies from 3-4 months (internal audit) to around 5 years (external audit). There are some industries that undertake external energy audits only on "as required" basis and there is no set timeframe for carrying out external energy audits.

In majority of plants top management takes the decision on energy investment. Only in one plant it was reported that the decisions on energy investment has been delegated to lower levels of management.

All the plants set energy conservation targets to improve energy efficiency. Most commonly used basis for setting up the energy conservation target is previous year's energy consumption. However, some new generation plants also use best international figures for same feedstock and fuel to set their energy conservation targets. In the fertilizer industry, the targets are usually expressed in terms of specific energy consumption and energy conservation targets are also specified in terms of proposed reduction in specific energy consumption figures. Few industries also use both the best energy consumption figures in fertilizer sector using same feedstock & fuel and the best operating practices among group plants as basis for setting their energy conservation targets.

With regard to energy consumption norms, it is difficult to give one single energy consumption norm for the fertilizer plants as these norms are expected to vary significantly with technology, fuel and feedstock used in the plants. The units have their own designed/guaranteed specific energy consumption that invariably becomes their energy consumption norm. Moreover, majority of old plants have revamped/retrofitted their process to reduce energy consumption and productivity.

TERI had carried out a study for PCRA in year 1994 (in collaboration with the Fertilizer Association of India (FAI)), to develop process energy consumption norms for the fertilizer industry. The results of this project are given table 5.3.4.

Table 5.3.4 Capacity utilization and energy consumption of Indian Ammonia Plants

Feedstock	Capacity utilization (%)	Energy GCal/MT
Gas	96.4	9.48
Naphtha	80.3	11.73
Gas + Naphtha	90.5	10.27
Fuel oil	91.2	13.90
Gas + Naphtha + Fuel oil	90.6	10.94
Coal	22.5	42.69
Gas + Naphtha + Fuel oil + Coal	86.6	11.43

Source: TERI Report No. IE/REP/94.004

5.3.5 Employee motivation and education

One of the most important factors to promote energy management at unit level is to develop and encourage the human resources to contribute to the process of energy management and energy efficiency. This ensures a correct mix of top-down and bottom-up approaches to bring about energy conservation. Motivation and education of employee forms a very important part of development of human resources for the industry. Most common practice to educate the employees is by organizing focused training programs. Majority of units conduct in-house training programs on energy efficiency and energy conservation. This reflects that majority plants have developed in-house technological capacity in energy efficiency aspects. Through internal training programs the knowledge is exchanged within the organization and capacity building takes place. In addition to internal training programs, most of the respondents also encourage their employees to take part in external training programs.

Other activities through which the industry encourages motivation of its employees for energy conservation is through participatory suggestion schemes and slogans. It has been proven that participation in incentive based suggestion scheme results in generation of new and innovative ideas to reduce energy consumption and improve productivity. The suggestion scheme, wherein all levels of workforce participates, is very crucial for generating incremental innovation to bring down energy consumption. The cumulative effect of small measures to conserve energy can be very significant. All the plants have a suggestion scheme in place to promote energy conservation. Majority of plants also promotes energy conservation by encouraging employees to provide slogans on energy conservation. The suggestion and slogan schemes are also followed by small financial incentives that encourage the staff to participate in these programs.

With regard to publishing of information/case studies on energy conservation, most plants encourage their employees to publish actively in the internal newsletter, and discuss the achievements in internal seminars. However, the extent of participation in external journals/publications was low. Only three respondents mentioned that encouragement is given to staff to publish about energy management achievement in journals.

Most of the plants covered under the survey responded that training of plant personnel on energy management is carried out on "as required" basis. However, there are a few units that conduct training on energy management on a regular basis. Half of the respondents mentioned that they have a separate budget for training. However, it is important to mention here that the training budget is overall budget and it includes all aspects of human resource development programs. In most fertilizer plants, energy management aspect is usually built into training related to process, automation and control, and other production and maintenance related aspects. However, there are some training programs specific to energy management.

5.3.6 Budget for energy conservation

Forty percent of companies responded that they have a separate budget for energy conservation. In rest of the companies, no separate budget is kept for activities related to energy conservation and management. However, this does not imply that for other companies, there is lack of investment for energy conservation projects. In majority of fertilizer plants, project approval and budgetary allocation for large projects is done on case to case basis. In the fertilizer sectors, having a separate budget for energy conservation represents a proactive approach by the plants to encourage implementation of energy efficiency projects.

In all the plants covered in the sample survey, policy for making investment in energy management projects is based on techno-economic analysis of the proposed scheme(s) and the quantum of energy that will be saved through the implementation of the proposed project. Majority of response shows that for large energy management projects (requiring large investments), approval from top management is needed.

5.3.7 Role of industry associations and peer group

Fertilizer industry presents a good example of openness and cooperation among industries. All the plants covered in the survey show that information exchange with industry association and peer group industries takes place by sharing information through plant visits. Sharing of case studies and accessing & sharing technical information through industry associations such as FAI are important means for exchange of information among plants.

Majority of fertilizer industry considers the role of industry association very crucial in providing information about energy management. All the respondents feel that fertilizer association plays an important role in the dissemination of information about energy conservation by organizing industry meet/seminars on energy management. The association also helps the industry by providing information about energy conservation opportunities and by providing technological database on energy efficiency. Few plants also expressed that the industry association helps in providing national/international benchmarks for energy consumption.

5.3.8 Barriers to implementation of energy conservation options

High first cost of technology/ energy efficient equipment is the main barrier to adoption of energy conservation measures in the plants. Another barrier to adoption of energy efficient technologies (mainly medium and large-scale investments) in the industries is inadequate government policies to promote energy conservation in the industry.

A few of sample plant also highlighted barriers related to capacity constraints and production disruption for adoption of energy efficient technologies. Reliable and assured supply of natural gas was also highlighted as one of the barrier to improve specific energy consumption (mainly related to the feedstock policies of the government).

5.3.9 Government policies and sectoral policies

The survey tried to gauge industry's perspective on national level policies that influence energy conservation and energy efficiency in the industry and policies specific to chemical and fertilizer that impact the fertilizer industry.

In the questionnaire survey, sixty percent of the respondents felt that existing government policies are not conducive to promote energy efficiency in the industry. Only four respondents felt that present government policies are conducive to promote energy efficiency and management at plant level. Majority of plants felt that additional support is required from the government in terms of equipment subsidy, legislation, R&D support, demonstration plants and physical incentives. Industry felt that in order to accelerate adoption and diffusion of energy efficient technologies that are capital intensive, government must provide additional support in capital (reduction in customs & excise concessions) and technology procurement.

On the aspect of sectoral policy pertinent to the Indian fertilizer industry, only two respondents felt that present sectoral policies are conducive to promote energy efficiency in the industry. However, majority of plants felt that present fertilizer policies are not adequate enough to promote energy efficiency in the industry. One of the main issues highlighted by the industry was related to lack of efforts from the government for evolving long-term policy that determines the future investment in the sector. Respondents felt that the companies should be allowed to realize gains due to energy savings for a longer period, which is presently it is restricted to 3 years only. It was brought out during the analysis that government policies must provide for higher rate of return on the investments made by plants on energy efficiency projects. These provisions must be made in the pricing mechanisms (Retention Pricing Scheme – RPS) for the fertilizer industry by setting reasonable energy norms based on feedstock, technology and vintage of the plant. The new policy must allow companies to take benefits of energy efficiency projects rather than mopping them up. Similarly, policy of 100% cap on production capacity, especially for oil based plants, affects promoting energy efficiency in the fertilizer plants.

It was felt that long-term sectoral policy should also specify the import policy for the fertilizer keeping in mind the domestic production of fertilizers.

5.3.10 Mandatory energy audits

On the issue of mandatory energy audits, the opinion of the respondents is represented in figure 5.3.10.

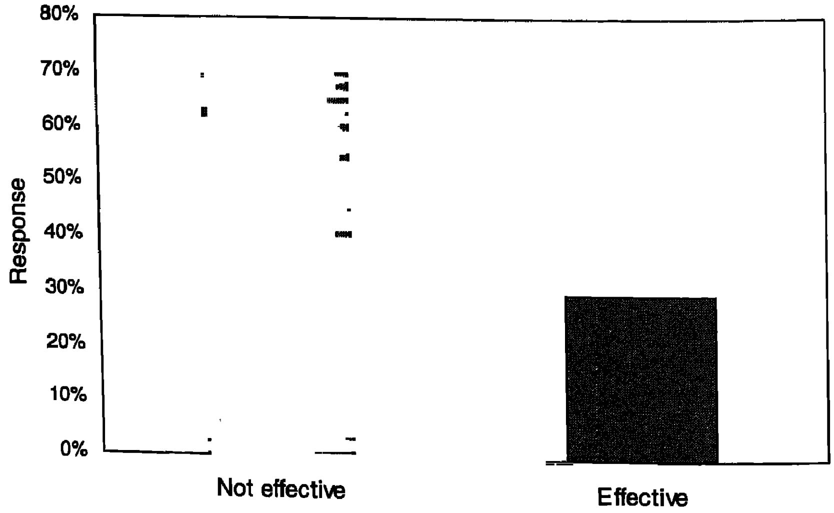


Figure 5.3.10 Effectiveness of mandatory energy audits in improving energy management/ energy conservation in industry

Only few respondents felt that the mandatory energy audits are useful for utilities and electrical systems. However, majority of plants was of the opinion that mandatory energy audits are not useful, as it does not represent a genuine effort by the industry to achieve energy management and energy conservation.

5.4 Field visits

5.4.1 Shriram Fertilizers and Chemicals (SFC), Kota

Integrated fertilizer complex at SFC Kota is located in Rajasthan and has installed capacity of 600 MTPD (metric tonnes per day) of ammonia and 1000 MTPD of urea. The plant uses naphtha as feedstock and fuel. It is one of the most energy efficient naphtha-based fertilizer plants in the country. The plant has continuously improved its performance over the years and achieved higher capacity utilization. Similarly, SFC Kota has been achieving progressively lower specific energy consumption per tonne of ammonia and urea over the years. SFC Kota represents a good example from the point of view of energy management. The process flow sheet for manufacture of urea at SFC Kota is given in Annexure 5.3.

The unit has both quality and environment policies, and these policies are publicly displayed. The unit has ISO 9002 and 14001 certification. SFC Kota is also a recipient of National Energy Conservation Award, 2001 administered by Bureau of Energy Efficiency, Ministry of Power, Government of India. Although, the unit does not have a formal energy management policy as yet, but energy management and energy conservation is critical focus of the management. The unit is in the process of formulating its energy management policy. Plant management believes that having a corporate policy gives clarity and systematic approach throughout the organization to meet the desired objectives.

Achievements of the unit on the energy front are discussed in detail in the annual report of the company. The annual reports mention about large energy conservation projects undertaken by the unit in last one year. Since energy cost forms around 82% of the cost of production, energy management is critical focus in all the policy planning exercises carried out by the plant. For formulating energy management policies, a discussion based cross-functional approach is adopted by the plant. All levels of management are involved in the brainstorming exercise that leads to the development of corporate energy management plan.

Although there is no separate "Energy Management (EM) Cell" in the plant, the Technical Services (TS)/R&D department performs all the functions and duties of a typical EM Cell. Members in this department are drawn from various departments (like ammonia plant, urea plant, off sites, captive power plant, etc.). There is multi-disciplinary team of engineers working in this department. Advantage of having cross-functional and inter-disciplinary team is that perspectives of all the areas are discussed for identifying and developing energy management projects. A senior management staff (General Manager) heads this department. The graduate engineer trainees recruited in the plant are also trained about the functional responsibilities of the TS/R&D department.

As part of its responsibilities, this department coordinates with other departments to identify new energy conservation projects. It also collates information on energy management projects that have been identified by other departments. For project execution and implementation, the department coordinates with engineering section and the concerned department where the project is to be executed. Smaller projects are usually executed in-house by the plant, although for larger projects sub-contracts are given for fabrication and project commissioning depending on the size and nature of the project. Daily energy consumption reports are prepared and circulated to all levels of management in the plant, including the corporate office at Delhi. Monthly follow-up meetings are held with top management to discuss key performance indicators and other key issues regarding the operation of the plant. Energy related issues are also reviewed and discussed in these meetings. Detailed reporting of energy, environment, quality and safety is done in these meetings. On the energy front, the performance is reviewed at a departmental level (e.g. ammonia plant, urea plant, power plant, etc.). Performance improvement areas under each section/department are also discussed in these meetings. Top management also reviews the progress of various schemes that are under implementation/consideration in different departments.

5.4.1.1 Initiatives to promote energy management

As part of innovative management, the plant organizes small group activities, although not focusing exclusively on the energy aspects. However, energy related issues are important in these small group activities carried out at the departmental level. Workers, junior management staff and middle management staff are involved in such small group activities. Such activities are carried out on a monthly basis by the plant. Incentives are given to those who suggest measures that can be implemented. The suggestions vary from small housekeeping activities to technical measures relating to large energy consuming equipment. Monetary incentive sharing scheme ensures that benefits are shared with the worker up to a maximum of Rs. 20,000/-. Such achievements are mentioned as news item in the internal magazine/news letter. To assess the potential for energy conservation, the plant conducts energy audit. Both internal and external energy audit teams conduct energy audits. However, the energy audits by external firms are conducted on a "as required" basis.

Plant has an internal system of setting targets for energy consumption. These targets are decided on the basis of (1) last year's energy consumption, (2) best energy consumption figures in the Indian fertilizer plants using same feedstock and fuel. While setting the targets emphasis is also given to best international norms for fertilizer plants based on same technology.

To promote employee motivation/education, the plant has a suggestion and slogan scheme on energy conservation. Plant personnel are trained in energy efficiency/management through both in-house and external training programs. The staff is encouraged to publish energy management achievements in journal/conferences. On some occasions the achievements of the plant have been presented at international conferences also. Similarly, energy efficiency achievements are discussed in internal newsletters. A company-wide HR module is under development, which will allow better management of training related activities. As of now, number of training days for each employee works out at 4 days per annum. Training on energy conservation/management is carried out on as per requirement basis. There is a separate training budget at corporate level. The unit has a good technical library to boast off.

The plant was optimistic about the positive role played by Fertilizer Association of India in promoting energy management in the fertilizer industries. The plant shares and accesses technical information through the association. It was highlighted that the fertilizer industries are open to share information with each other and share case studies on energy management with other plants. The conferences organized by FAI provide a good platform to discuss and share information for the industry. The technical library of FAI is very useful in providing technical literature relevant to the industry. FAI also provides information about energy management opportunities through its own publication and also provides technological database on energy efficiency. The association also provides the industry with national and international benchmarks for energy consumption.

5.4.1.2 Investment in energy management projects

The plant does not have a separate budget for energy conservation. However, energy conservation aspects are taken into account during annual production planning exercise carried out at the level of top management. The top management always approves yearly plans in advance. Major retrofit measures are always appraised on the basis of production, energy and quality issues. For making investments in energy conservation projects, a thorough techno-economic analysis is carried out, which weighs the quantum of energy savings with the extent of investment required. On a regular basis, emphasis is give to those projects that can be executed in-house by the plant. Larger investment projects need formal approval by the top management.

Plant has undertaken several large revamp/retrofit projects in the past that have helped to improve productivity and bring down the energy consumption levels also.

5.4.1.3 Government policies

The management feels that present government policies are not conducive to promote energy management in industry. More legislative support is needed from the government in the form of fertilizer pricing system to be more oriented to promote and reward energy conservation in the industry.

Government must also give custom and excise duty relief for purchase of capital equipment. Subsidy must be given by the government to promote the use of energy efficient equipment. R&D support for selected projects must be provided by the government. Industry can carry out collaborative research to promote energy conservation.

The industry was critical of the prevailing *ad hoc* fertilizer pricing policy of the government. It was felt that there should be consistency in the fertilizer pricing policy, at least in the medium-term. This will enable the plants to decide and make investments in energy management options. As of now the benefits of energy conservation options are available to the plant for a limited period only (~3yrs), and after that time the benefits of energy conservation are mopped up by the government. The government must ensure fair return on investment (RoI) for all energy management projects. Plant has identified some measures for energy conservation but the decision on investment is deferred due to uncertainty in government policies for the fertilizer industry.

Similarly, feedstock pricing polices must be firmed up by the government for the fertilizer industry. For captive power plants, wherever possible, high-grade coal must be made available.

The State of Rajasthan does not have any legislation for mandatory energy audits. However, it is felt that mandatory energy audits would not go a long way in promoting energy management. It is expected that there will be no genuine effort on energy management by the plant.

5.4.1.4 Barriers to implementation of energy conservation measures

As per the plant the main barrier to implementation of energy conservation measures is inadequate government policies to promote energy management in the industry. Second most important criterion highlighted by the plant was high cost of technology/energy efficient equipment. Also the plant highlighted budgetary constraints for the fertilizer industry as a barrier to invest in energy conservation projects. Also the license fee charged by the process licensors is very high and forms 20-30% of the technology cost.

5.4.1.5 Major issues for effective energy management policy

The first and foremost thing in an energy management policy of the plant. This will ensure that the plant implements the guidelines adopted in the policy, and the top management will have strong commitment for promoting energy conservation activities.

Next most important thing from the viewpoint of energy management policies is to regularly conduct energy audits to identify energy conservation opportunities and to install energy efficient equipment. With regard to implementation of energy management projects industry must look forward to development of indigenous capability to implement energy management projects.

R&D projects (including joint R&D with other companies) must be undertaken to develop energy management solution in the plant. Maintaining a constant interaction with technology suppliers can further augment this effort. In a complex process industry like fertilizer, it is always beneficial to maintain constant links with the technology suppliers.

Most of the fertilizer plants have technical services department that to a large extent performs the duties of energy management cell. However, setting up an energy cell headed by a full time energy manager will give further impetus to energy conservation efforts.

For fertilizer industry having high percentage of energy cost as a percentage of cost of production, it is essential to carry out energy monitoring and targeting. Majority of plants in the fertilizer industry rigorously conduct monitoring and targeting to bring down energy consumption levels. Due to similar reasons, it is a practice in the fertilizer plants to consider energy as an important aspect in all redesign and retrofit measures undertaken by the plant.

The policy should also motivate the staff to actively participate in energy conservation projects in the plant through suitable incentive schemes to reward the employees.

5.4.2 Zuari Industries Limited (ZIL), Fertilizer Division

The fertilizer division of Zuari Industries Limited is located in the state of Goa. The facility has production of straight nitrogenous fertilizer and complex fertilizers. The installed capacity of ammonia and urea plants is 660 MTPD and 1140 MTPD respectively. The plant uses naphtha as feedstock and fuel. Among naphtha based plants in the country, this plant has been performing efficiently over the years. The plant has consistently achieved good capacity utilization and reduced its specific energy consumption over the years. Plant had implemented a number of technical measures in past several years to bring down the energy consumption level. However, the present level of energy consumption in the plant is significantly higher than that of best naphtha based plants operating in the country.

The unit has a SHE (safety, health and environment) Policy. However, there is no quality and energy policy in place for the plant. The SHE policy of the company is displayed publicly in the plant.

Cost of energy forms around 85% of the total cost of production. Energy management is a critical focus of the top management and top management participates on a regular basis in planning and review of various energy management projects. The annual reports of the company briefly discuss the details about energy management policy and projects. With regard to formulation of energy policy and energy plans, the corporate office takes most decisions. However, department heads are consulted before-hand in the process. Frequent discussions are held with top management to discuss energy consumption issues. Yearly action plans are prepared in advance by the plant. These plans are discussed in terms of raw material consumption and energy usage in the plant(s).

The plant does not have a separate energy management cell, but there is a technical services (TS) department that looks after the issues related to energy conservation and energy efficiency. Together, TS and BMI (Budgeting and Management Information) departments, keep a close monitoring on the energy consumption (raw materials). TS department has only chemical engineers that look after the energy monitoring and reporting. Engineers working in TS department can be transferred to other departments if there is any requirement. However, such postings are only temporary.

As part of its responsibilities, TS department helps is identification of energy management projects. The department coordinates with other departments to identify opportunities to conserve energy. Weekly status reports on energy consumption are prepared for review by different levels of management. The department conducts in-house training program for workers and also interacts informally with other departments to motivate them to conserve energy. Most of such training takes place during the annual shut down taken by the plant. Other responsibilities of this department includes, sending technical data to FICC/Dept. of Chemicals and Fertilizers, stock calculations, trouble shooting, coordinate technical studies, etc.

5.4.2.1 Initiatives to promote energy management

The plant organizes small group activities for bringing about technological and operational improvement. The small group activities are not specific to energy management, but staff can give useful suggestion in monthly technical meetings. The level of involvement in such meetings is shop floor and junior management staff. Employee motivation for energy management is promoted through a suggestion scheme. The suggestion scheme was started last year and under this scheme cash awards are given to individuals who recommend viable ideas that are implemented in the plant. Plant has implemented a lot of energy conservation measures over the years to progressively bring down the specific energy consumption. Plant has identified and implemented lot of measures in heat recovery system, which were found lucrative in terms of payback period. The plant itself, with support from engineering and production departments, implemented many measures. The plant has brought down specific energy consumption from 8.18 GCal/MT of Urea in the year 1984 to 7.325 GCal/MT of Urea in the year 2000-01.

The management feels that the plant has reached a saturation point for making incremental improvements in technology to achieve further improvement in energy efficiency. Increasingly, the plant is facing capacity constraint to implement energy conservation opportunities. Recently, M/s TEC, Japan (the original technology suppliers and designers of the plant) conducted a feasibility study to undertake major revamp of the production process. The feasibility study recommends a major revamp of the plant involving an investment of Rs. 400 crores leading to energy saving of the order of 1.04 GCal/MT and 0.4 GCal/MT in ammonia and urea plants respectively.

Plant does not conduct energy audits on a regular basis. Plant had conducted only one energy audit in the year 1987/88.

As a driver for energy management, plant sets energy conservation targets that are based on consumption norms. These targets are based on last year's energy consumption. The plant also conducts limited number of external training programs on energy efficiency (e.g. related to pumps, etc.). The plant has a bi-monthly magazine that also reports and discusses various energy management achievements.

There is no yearly training budget, and training programs related to energy management are conducted on as per requirement basis.

The plant management was appreciative of the role played by FAI. In general, the plant management felt that interaction among all the fertilizer plants in India is very good and there is sharing of information among the plants. The magazines published by FAI facilitate such interaction between firms. The plant shares its achievements in energy conservation with other plants in the country, although not so much through published literature.

FAI has provided excellent forum, in the form of meets/seminars, for industry to discuss their achievements in energy management. FAI, through its publications and well-stocked technical library, provides a technological database on energy efficiency and national/international benchmarks for energy consumption.

5.4.2.2 Investment in energy management projects

During annual budgeting exercise, no separate budget is kept for energy conservation. However, since cost of energy forms 85% of the cost of production, energy management is inherently embedded in all annual-planning exercises. Top management takes most decisions on investments. Investments in energy management projects are made on the basis of sound techno-economic analysis and quantum of energy saved is an important criterion in decision making. Emphasis is given to those energy management projects that can be executed in house and for large energy management projects approval is needed from top management.

5.4.2.3 Government policies

During the discussions it was brought out that the present government policies are not conducive to promote energy efficiency in the industry. Government support in the form of equipment subsidy and demonstration plants is needed to promote energy efficient technology in the industry.

With regard to the fertilizer industry, the management feels that present government policy on chemical fertilizers and its pricing is not conducive for promoting energy management in the fertilizer plants. The government should set reasonable energy norms for the industry based on feedstock, technology used and the vintage of the plant. Benefits of any improvement in energy consumption over the set norms should accrue to the unit/company and should not be mopped up by the government. A mechanism that brings about sharing of benefits due to improved energy efficiency will represent a win-win option.

In past few years there has been no consistency in the policies towards chemical fertilizers. Such inconsistency has forced the industry to defer any large investments in plant and machinery to improve their performance. A clear long-term policy from the government is required for chemical fertilizers. Zuari Industries has also deferred large investment to be made in revamp/retrofit that would lead to significant energy savings.

With regard to feedstock used by the fertilizer units, government must come out with clear policy guidelines. Natural gas is the most preferred feedstock for production of fertilizer. Presently, around 30% of capacity are based on naphtha feedstock and all naphtha-based fertilizer plants in the country face an uncertain future. Government must come out with clear policy if it wants the naphtha based fertilizer plants to operate in the country in long-term. Alternatively, government must allow companies to set up plants abroad where the feedstock and fuel costs are lucrative to produce fertilizer. With regard to supply of alternate gaseous fuel (LNG), firm prices must be notified to the plants for making any decision.

Mandatory energy audits are not enforced in the state of Goa. For any energy audit to be effective, there must be an initiative at plant level, and mandatory energy audits will lead to dilution of the objective of energy audit study.

5.4.2.4 Barriers to implementation of energy conservation measures

The plant feels that high cost of technology/energy efficient equipment is the main barrier to implementation of energy conservation options at plant level. The plant also feels that there are inadequate government policies to promote energy management in the industry. With regard to the fertilizer industry, the management is uncertain if the company would reap the benefits of energy conservation project.

5.4.2.5 Major issues for effective energy management policy

The foremost thing to promote energy conservation is top management's commitment towards energy conservation. Strong commitment from top will ensure that energy management projects will get adequate support from top management. Similarly, the motivation at lower levels to conserve energy will be high.

Within the organization of the company, an energy management cell headed by a full time energy manager will give impetus to energy management. To formalize the flow of energy information in the plant, a proper energy management information system (EMIS) must be put in place. The EMIS system can be integrated with existing systems to collect and collate data on energy management.

As part of energy conservation strategy, plant must adopt monitoring and targeting scheme to reduce energy consumption. The targets can be set based on a mutual consultative manner and all efforts should be made to achieve those targets.

5.5 Issues to be stressed while framing the energy policies of the fertilizer industry

An analysis is presented here regarding the key aspects that need to be considered for formulating energy management guidelines at corporate level.

5.5.1 Role of top management

In order to secure commitment from the shop floor, it is imperative for top management to demonstrate its commitment to promote energy management and energy conservation at corporate level. Strong and focused leadership is crucial for carrying forward an integrated energy management plan that includes all levels of management and entire shop floor.

Since energy forms a large part of the costs of production, all the plants realize the importance of role of top management and rate it as a crucial parameter that must be stressed while making corporate/plant level energy management policies.

5.5.2 Setting up energy management cell

'Since energy is everybody's business, therefore it is nobody's business', this is the attitude that is usually visible in organizations that do not have clear guidelines on energy conservation and management structure to support implementation of energy management programs. Having an organizational set up that rests energy management as a core responsibility of a group/functional unit is central to achieving energy management goals at corporate/plant level. Popularly, these organizational equivalents are called the "Energy Management Cell - EM Cell". EM Cell is expected to coordinate with all the departments within the plant to identify, develop and execute energy management projects. Its responsibilities are cross-functional and headed by a full time energy manager. Apart from having a multi-disciplinary team of professionals in the

EM Cell, some of the plant staff should be placed on deputation in EM Cell on rotation basis to get exposure to the operation and functioning of the EM Cell.

Implementation of the provisions of Energy Conservation Act will make it compulsory for all energy intensive industries to have EM Cell headed by a full time energy manager. Appointed energy managers will have to obtain certification form the Bureau of Energy Efficiency through a recognized competence based examination system.

Therefore, setting up energy management cell is another main area that must be stressed in corporate energy management policies. All the respondents to the questionnaire survey have highlighted this as an important aspect.

Although majority of fertilizer units has Technical Services/Engineering departments that routinely carry out main functions of a typical EM Cell, having a separate EM Cell would certainly give focus and objectivity to the energy management activities in the plant.

5.5.3 *Energy audit*

Third most important aspect highlighted in the questionnaire survey is related to carrying out regular energy audits of the facilities. Energy audits help in identifying the possible areas of energy conservation along with techno-economic analysis to enable implementation. Energy management policy must emphasize the role of other energy audits as a tool to identify major energy consuming areas and improve energy efficiency. However, the general view of the industry was that these energy audits must not be made mandatory because the objectivity and purpose of the effort can get lost in the process.

5.5.4 *Monitoring and targeting*

Monitoring and targeting of key energy parameters help the industry to benchmark and compare its own performance over the years. The industries can also compare their energy performance with other industries nationally and internationally.

Industries also regard this as an important part of the energy management policy.

5.5.5 *Internal energy award system and ushering a culture of preventive and predictive maintenance*

In order to motivate the staff (including shop floor workers) to participate actively in energy management exercise, an incentive/reward scheme should complement participatory approach involving group activities. Majority of plants feels that a system of rewards (including financial rewards) acts as a catalyst to motivate employees to provide suggestions and schemes to reduce energy conservation. However, in majority of plants, the small group activity and incentives programmes are carried out for overall productivity improvement, where energy management becomes a subset of overall productivity. Since energy is a very crucial input in fertilizer plants, any productivity management exercise will invariably treat the issue of energy management/conservation as priority.

"Prevention is better than cure" – this is certainly true for the plant and equipment. Better maintained plant and equipment not only save on loss of production but also help in minimizing energy consumption in plant and equipment. Therefore, preventive and predictive maintenance schedule should be emphasized in company's energy management policy.

5.5.6 *Energy management information system (EMIS)*

Like any typical MIS, objective of EMIS is to enable different levels of management to review and monitor the energy consumption. With help of EMIS systems, energy consumption status reports can be generated for suiting the needs of different levels of management.

5.5.7 *Training and capacity building*

Development of human capacity is very crucial to generate new and innovative ideas in-house for promoting energy management. It is important that companies develop specific training modules related to energy efficiency and management as part of its HRD training policy. This can be done by encouraging the plant to participate in both internal and external training programs on energy management and energy conservation.

In addition the staff should be encouraged to publish achievements in energy management in both internal and external publications. Similarly, personnel can also participate in relevant national and international conferences to exchanges ideas on relevant subjects. Industry associations can play a crucial role in these cases.

Annexure 5.1

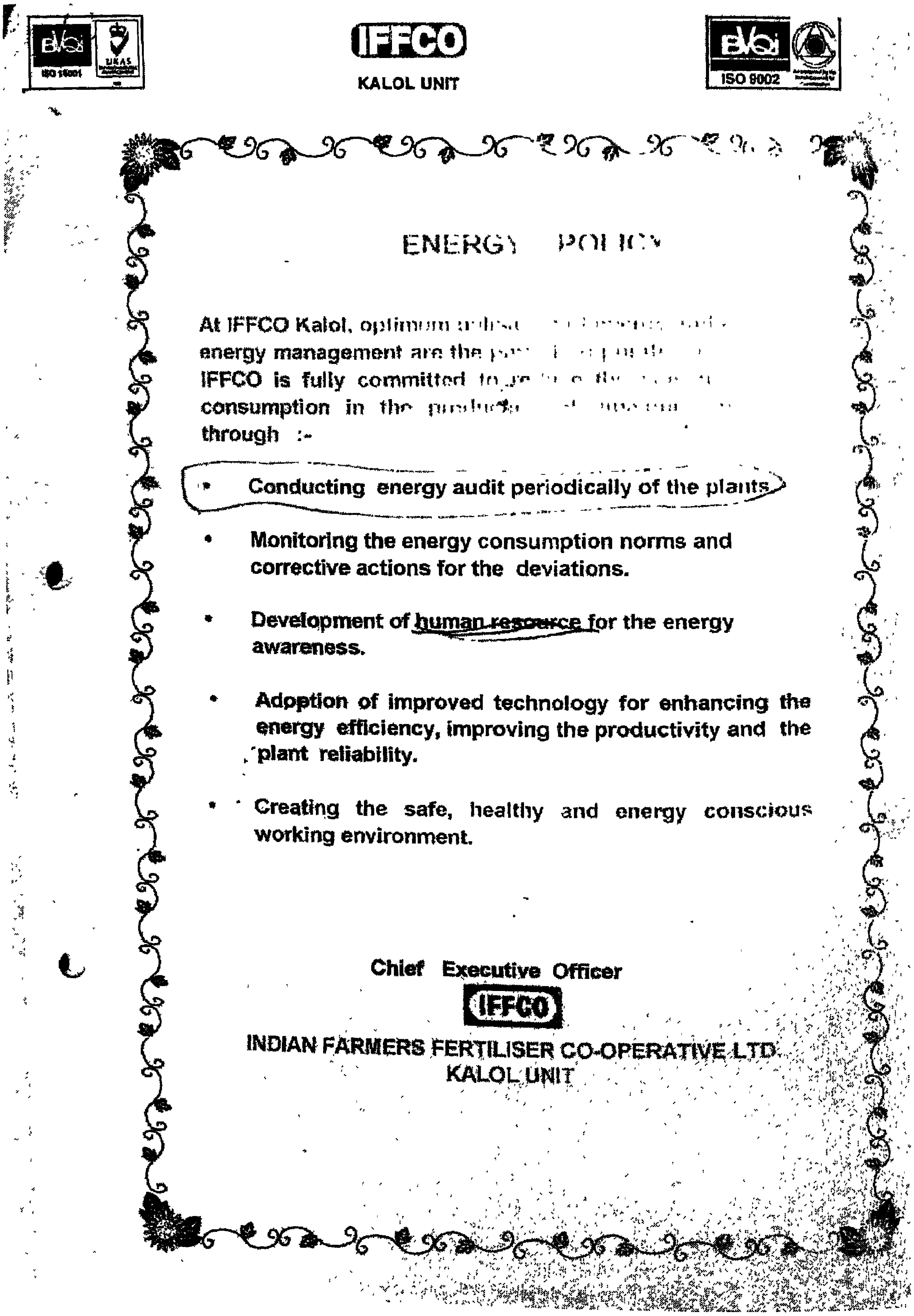
Summary of data collected from different plants

The data on specific energy consumption for urea is given below for the plants that were covered under the questionnaire survey.

	Feedstock	Installed capacity (MT)	Capacity utilization (%)			Specific energy consumption (GCal/MT)		
			1998-99	1999-2000	2000-01	1998-99	1999-2000	2000-01
Plant A	Natural gas	774782	123.5	122.1	114.7	6.16	6.15	5.92
Plant B	Naphtha	775500	NA	92.14*	110.13	N.A.	6.15*	5.81
Plant C	Naphtha	495000	115.2	102.6	101.7	8.19	8.02	7.87
Plant D	Naphtha	726000	115.2	111.0	100.0	6.32	6.29	6.26
Plant E	NG/Naphtha	544500	95.4*	86.66	89.59	6.74	6.81	6.73
Plant F	Natural gas	1452000	104.44	107.26	112.3	6.42	6.32	6.10
Plant G	LSHS	511500	98.48	106.23	93.57	9.79	9.74	10.21
Plant H	Naphtha	376200	89.48	114.32	104.77	7.90	7.58	7.33
Plant I	Naphtha	NA	NA	NA	NA	NA	NA	NA
Plant J	NG/Naphtha	445500	113	127	115	5.74	5.53	5.53
Plant K	NG/Naphtha	1485000	97.16	100.24	89.52	7.14	7.11	7.11
Plant L	Naphtha	330000	119.1	122.6	98.4	7.37	7.35	7.53

* Capacity utilization and specific consumption at part load operating capacity.

Energy policies



IFFCO

KALOL UNIT

ENERGY POLICY

At IFFCO Kalol, optimum utilisation [illegible] energy management are the [illegible]. IFFCO is fully committed to [illegible] consumption in the [illegible] through :-

- **Conducting energy audit periodically of the plants**
- **Monitoring the energy consumption norms and corrective actions for the deviations.**
- **Development of human resource for the energy awareness.**
- **Adoption of improved technology for enhancing the energy efficiency, improving the productivity and the plant reliability.**
- **Creating the safe, healthy and energy conscious working environment.**

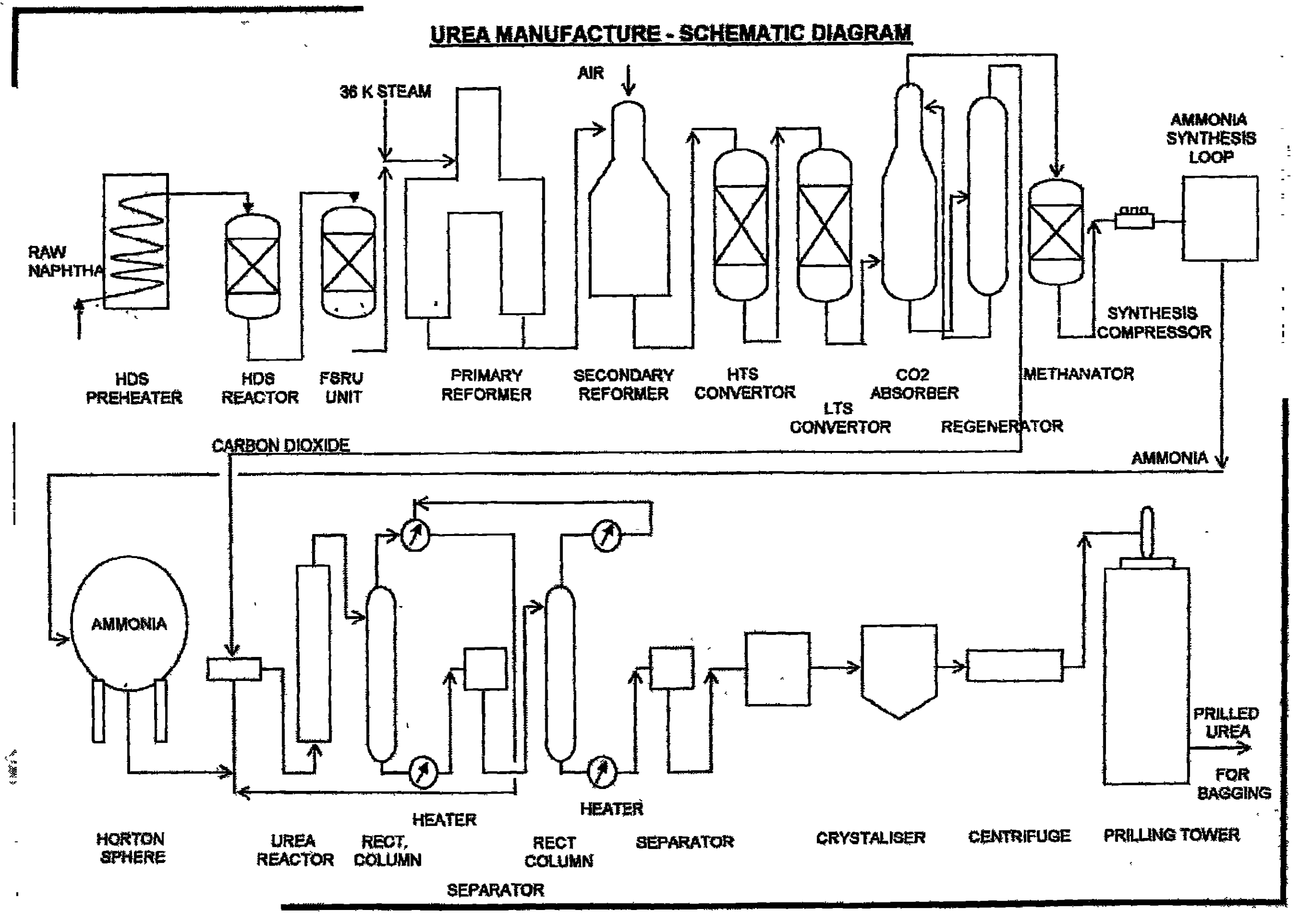
Chief Executive Officer

IFFCO

INDIAN FARMERS FERTILISER CO-OPERATIVE LTD.
KALOL UNIT

Annexure 5.3

Process flow sheet for manufacture of urea at SFC Kota



6

Petrochemical Industry

6.1 Profile of sector

The petrochemical industry has developed out of the petroleum industry as a result of the realisation that petroleum offered infinitely more possibilities than primarily use as a fuel and lubricating oil. The product range of the petrochemical industry is diverse and includes polymers, synthetic fibres, elastomers, detergents and surfactants.

The petrochemical industry is one of the fastest growing industrial sectors in India today. Its growth rate is 14-15%, which is more than double the growth rate of GDP [1]. Indian Petrochemicals Corporation Limited (IPCL), and Reliance Industries Limited (RIL) dominate the Indian petrochemical industry. Major recent entrants to the industry are Gas Authority of India (GAIL) and Haldia Petrochemicals. Steam crackers are at the heart of petrochemical complexes. Presently there are seven cracker complexes in operation in the country with a combined ethylene capacity of about 2.5 million tonnes per annum. The major ethylene cracker complexes in India are given in table 6.1.

Table 6.1 Ethylene cracker complexes in India [2]

Company	Location	Feedstock	Installed capapcity (tpa)	Expansion plans
IPCL	Vadodara, Gujarat	Naphtha	180,000	Proposal to scrap old plant and replace it with a 300,000 tpa naphtha cracker
	Nagothane, Maharashtra	Natural Gas	400,000	
	Gandhar, Gujarat	Natural Gas /Naphtha	300,000	
Reliance	Hazira	Naphtha/ Natural Gas	750,000	
GAIL	Auriya	Natural Gas	300,000	200,000
Haldia Petrochemicals	Haldia, West Bengal	Naphtha	420,000	180,000
NOCIL	Thane, Maharashtra	Naphtha	63,000	

Both thermal and electrical energy are used in petrochemical sector. Petrochemical processes are energy intensive and energy costs can amount to as much as 50% of the variable manufacturing costs. Hence there is considerable scope for energy conservation in petrochemical plants. Since some of the petrochemical plants in operation today were built over 30 years ago, they employ technologies that are not necessarily energy optimised. The specific electricity consumption in the sector is in the range of 345 to 3,860 kWh/tonne and the specific thermal energy consumption is in the range of 0.04 to 8.61 MkCal/tonne [3]. The national norm for the overall specific energy consumption is 6.05 MkCal/tonne compared to the international norm of 2.5 MkCal/tonne [3].

For the sake of simplicity, the following petrochemical products were selected for further analysis in this report.

- Poly vinyl chloride (PVC)
- Purified terephthalic acid (PTA)
- Di-methyl terephthalate (DMT)

PVC is one of the most important commodity plastic. DMT and PTA are important intermediates used for producing a range of down-stream products such as polyester (yarn and staple fibre) and polyethylene teriphthalate (PET). Summary of data collected from plants is given at Annexure 6.1.

Salient features of Indian Petrochemical industry in India

- Oil and natural gas are used as feedstock as well as fuel source
- Technology improvements have occurred in last 30 years.
- Growth rate is 14-15% even though it is highly capital intensive sector of the economy
- Economies of scale has a significant impact on the cost of production and including the cost of energy
- Specific electricity consumption ranges from 345 to 3860 kWh/t and specific thermal energy is in the range from 0.04 to 8.61 MkCal/t of product.
- Most of the plants have Energy Management Cell to monitor energy consumption and guide conservation measures.

6.2 Analysis of Part A (Quantitative details)of questionnaire

A major constraint experienced during the study was the secrecy adopted by some of the petrochemical plant's management even to share plant specific data. Hence only one questionnaire was received during the questionnaire survey. TERI team visited two plants for discussions with the plant management - Reliance, Patalganga and Reliance, Hazira. The observations of the TERI team have been incorporated at appropriate places in the report. Due to lack of plant specific process data, the analysis below draws upon additional information already available in the public domain.

6.2.1 Installed capacity

The break-up of the installed capacity of PVC in India is given in table 6.2.1a.

Table 6.2.1a Installed capacities of domestic PVC manufacturers

Producer	*Installed capacity (tonnes)*
IPCL, Vadodara	55,000
IPCL, Gandhar	150,000
Reliance, Hazira	275,000
Reliance, Jamnagar	200,000
Finolex, Ratnagiri	130,000
Shriram, Kota	33,000
Chemplast, Mettur	60,000
Total	903,000

The break-up of the installed capacities DMT and PTA are given in table 6.2.1b.

Table 6.2.1b Installed capacities of domestic DMT and PTA manufacturers

Producer	Installed capacity (tonnes)
DMT	
IPCL, Vadodara	30, 000
Bombay Dyeing, Maharashtra	160, 000
Bongaigaon Refinery and Petrochemicals Ltd (BRPL), Assam	52, 000
Garware Chemicals Ltd, Maharashtra	60,000
Total	302,000
PTA	
Reliance, Patalganga	250, 000
Reliance, Hazira	350, 000
Reliance, Hazira	350, 000
SVC Superchem, Mathura	120, 000
Total	1070, 000

6.2.2 Raw material usage

PVC is produced by suspension polymerisation of vinyl chloride monomer (VCM). Ethylene and chloride react to yield ethylene dichloride (EDC). EDC is thermally cracked to VCM and hydrochloric acid (HCl). HCl is then separated from the product. Additional EDC obtained is recycled in to the thermal cracking unit.

The primary raw material for production of DMT and PTA is p-xylene. The main sections of the PTA plant are the paraxylene oxidation (reactor), catalyst preparation, solvent recovery, and product purification.

6.2.3 Product type

Commercially two types of PVC are used: flexible and rigid type. The major applications of flexible PVC are wires and cables, toys, footwear and calendered sheets. Rigid PVC is mainly used to produce pipes and fittings, films and foils, and bottles, and profiles.

PTA and DMT are feedstock for production of polyester staple fibre (PSF) and polyester filament yarn (PFY).

6.2.4 Fuel Usage

The main energy inputs in petrochemical plants are:

- Power, which comes mostly from captive power plant
- Gaseous and liquid hydrocarbons produced in the manufacturing processes
- Fuel oil purchased from refineries

Comparing the energy intensity of petrochemical products by different organisations is difficult due to differences in feedstocks and energy accounting practices. A comparison of latest and previous specific fuel consumption norms for manufacture of PVC by suspension process is given in table 6.2.4a. It is worth noting that due to advances in technology, the specific fuel consumption has been brought down by almost 33% in new plants, compared to plants set-up just two decades ago.

Table 6.2.4a Comparison of specific energy consumption of PVC manufacture

S.No	Item	Unit	Consumption norm (latest)	Consumption (in 1980s)	Reduction
1.	Power	kWh/t	150	225	33%
2.	Steam	t/t	0.90	1.26	30%

The specific energy consumption figures per tonne of DMT for technology of Dynamit Nobel, employed by some installed plants are given in Table 6.2.4b.

Table 6.2.4b Specific consumption of DMT manufacture [6]

Item	Unit	Consumption
Power	kWh/t	800
Steam	t/t	3.5

Typical specific energy consumption for PTA manufacture is given in table 6.2.4c.

Table 6.2.4c Specific consumption of PTA manufacture [7]

Item	Unit	Design
Steam	t/t	0.16
Power	kWh/t	456

6.2.5 Technological status

6.2.5.1 Plant size

Scale of operation of older petrochemical plants is very small compared to international standards. For example, the Government recommends a capacity of 100,000 tpa as minimum economic size (MES) of PVC plants. However, as seen in table 6.2.1a, many plants in India set-up earlier are below the MES norm. Continuous processes of petrochemicals are guided by the 'six-tenth' rule, which means that if capacity is doubled, the cost of the plant is only increased by approx. 60%.

PVC was the first polymer to be manufactured at Hazira by Reliance, when the plant started in 1991. The technology supplier for the PVC plant is Geon, U.S.A (formerly B. F. Goodrich). The rated output of the PVC plant then was more than the total Indian demand.

6.2.5.2 Selection of technology

Selection of technology is vitally important in petrochemical sector, as is highlighted from the historical development of PTA and DMT in the country. Reliance was the first to build a PTA plant in Patalganga in 1985 when others were investing on DMT. The primary reason for adopting the PTA route by Reliance was the lower capital cost of the technology compared to DMT, since PTA does not require an intermediate extraction plant. The technology supplier for Reliance's PTA plants is Dupont (formerly technology was owned by ICI).

6.2.5.3 Process improvements

Process improvements play a major role in petrochemical sector. An example of process improvement in PTA process carried out successfully by RIL, Patalganga is installation of an additional air compressor to supply more air to the paraxylene oxidation reactor in the PTA plant. The additional air supply has increased the output of the reactor greatly.

6.2.6 Major energy conservation measures

Some major energy conservation measures implemented by petrochemical industry are given in table 6.2.6.

Table 6.2.6 Examples of energy conservation projects successfully implemented by petrochemical companies

	Project description
PTA	One cooling water circulation pump and cooling tower fan was stopped after optimizing the cooling water consumption
	Modification of LP steam header control system led to stoppage of venting of steam generated in PTA plant
	Processing of xylenes stream through the new crystalliser in PX section
	Removal of bypass lines for all the steam traps in the PX plant
	Usage of process recycle water from PTA purification leading to,stoppage of 2 pumps
	Usage of conveying gas in place of N_2 in the PTA plant for process requirement
	FRP blades in place of aluminium for DH column fin fans in the PTA oxidation section
	Sale of power has led to reduce specific fuel consumption and higher cogeneration efficiency for GT and HRSGs. Increase in pressure enable to utilize exhaust steam in the processes
PVC	Improved condensate recovery in PVC plant
	Introduction of basket type strainer in PVC plant waste water area
	Additional spiral heat exchanger in series for feed stream of stripping column
	Dryer burner management system commissioning
	Optimization of new chilled water supply pumps (stoppage of two nos.)
	Conversion of fuel in PVC dryer from MP steam to cracker plant fuel gas
	Conversion of EDC cracking furnace from naphtha fired to cracker fuel gas fired
	Reduction in plant air compressor discharge pressure from 3.2 to 2.5 kg/cm^2g in PVC plant
VCM	Optimisation of fuel gas in 2 furnaces in VCM plant
	Heat recovery from VCM column bottom in VCM plant to conserve steam/ cooling water
	Steam to feed ratio reduction in Heads-II column has reduced steam consumption
	Optimisation of VCM column and Hi boil column has resulted in savings of 16000 MTA of IP steam
	Conversion of EDC cracker furnace from naphtha fired to cracker gas fired

6.3 Analysis of Part B (Energy management practices) of questionnaire

This section is based on the discussions held during the plant visit to Reliance, Hazira and Patalganga by TERI team and annual reports of other leading manufacturers like IPCL.

6.3.1 Energy policy

Most of the leading petrochemical companies such as Reliance and IPCL, have a well-defined energy policy (Annexure 6.2). The policy broadly spells out the vision of the management in promoting energy conservation, increasing energy awareness, using benchmarking tools, need for conducting periodic energy audits and promoting use of renewable energy sources. A few other companies, like NOCIL, do not have a separate energy policy but emphasise the need to improve energy efficiency in their processes, and the environmental improvements.

6.3.2 Commitment to energy conservation

There is little doubt that the top management of all the leading petrochemical companies is very much committed to energy conservation. Top management commitment ensures that energy conservation is followed in the design and operation of the plant. Optimum specific consumption of raw materials and energy is one of the main evaluation criteria during selection of a new technology. Fuel substitution, de-bottlenecking and energy optimisation are routinely practised during operation of the plants. The companies also employ external energy auditors and publish energy conservation measures undertaken by them in their annual reports.

Usually, there is an 'Apex Group', headed by the Director or President of the plant. This 'Apex Group' reviews the energy consumption trends of the complex, various energy conservation schemes and takes major decisions. The head of the energy conservation cell and various heads of the different manufacturing plants and technical services constitute this 'Apex Group'. The presence of the 'Apex Group' is itself an indication of the commitment of the management to energy conservation.

6.3.3 Energy conservation cell, its organisation and role

All petrochemical companies have vibrant energy conservation cells. The cell is usually headed by a very senior manager, usually of the rank of General Manager (GM) or Assistant GM. The head of the energy cell reports directly to the head of operations.

The head of the cell, along with normally one to two engineers, form the 'Core Group'. The 'Core Group' is responsible for compilation of energy consumption data, MIS reporting to top management, arrangements for external audits, and compilation and prioritisation of energy conservation schemes.

Further, each manufacturing plant nominates an Energy Co-ordinator from amongst its operational personnel. The energy cell works with the plant Energy Co-ordinator and respective plant technical services engineer to form the 'Working Group'. This group is usually responsible for conceiving and implementing new energy conservation schemes.

6.3.4 Small group activities

As mentioned, there are small 'Working Groups' in most petrochemical companies. In addition, some progressive plants organise other group activities in which participation of every technical personnel is mandatory. Each group is responsible for conceptualising and developing a specific cost-saving idea. All the different groups in the company come together every year to present their project ideas to other groups. This kind of group work promotes interaction across functions and helps in development of many new ideas within the company.

6.3.5 Role of energy audit

Petrochemical companies are quite conscious of the role of energy audit in energy conservation. Most plant conduct energy audit on a regular basis, both in-house and through external agencies.

The in-house team conducts periodic audit to identify areas of energy wastage in the plant. Some typical areas where internal team concentrates are steam traps, electric motors etc. Insulation maintenance work, which is done round the year, is usually entrusted to an external insulation vendor in petrochemical companies. Some plants have also entrusted the steam trap vendor for routine maintenance of steam traps.

Both domestic and international external auditors have also been employed from time to time by most companies. There have been some very good examples of in-house capacity building through working with external auditors in this sector. Based on the learning's acquired from external auditors, energy audits have been undertaken by in-house teams subsequently.

6.3.6 Energy conservation budget

In petrochemical companies, funds are usually not a constraint for energy conservation schemes that have attractive payback period. The different energy conservation projects are analysed for anticipated savings and approximate investment based on which they are prioritised for implementation. The finance for various energy conservation projects are either allocated separately or provided from the respective plant budgets.

6.3.7 Target setting

Targets are usually set based on last year's energy consumption. The reduction target of specific energy consumption is in the range of 2 to 3 % in most companies. The targets set are communicated to the respective plants. Periodic review is done and the deviations from the target are acted upon. Positive achievements in the current year remain as benchmarks for the next period and hence continual improvement is achieved.

6.3.8 Motivation

A number of measures to motivate the employees to minimise energy wastage are followed by petrochemical companies. These include suggestion schemes, in-house training programmes on energy conservation, external training programmes and internal reporting and communication of outstanding achievements.

6.4 Field visits

6.4.1 Reliance Industries Limited (RIL), Patalganga

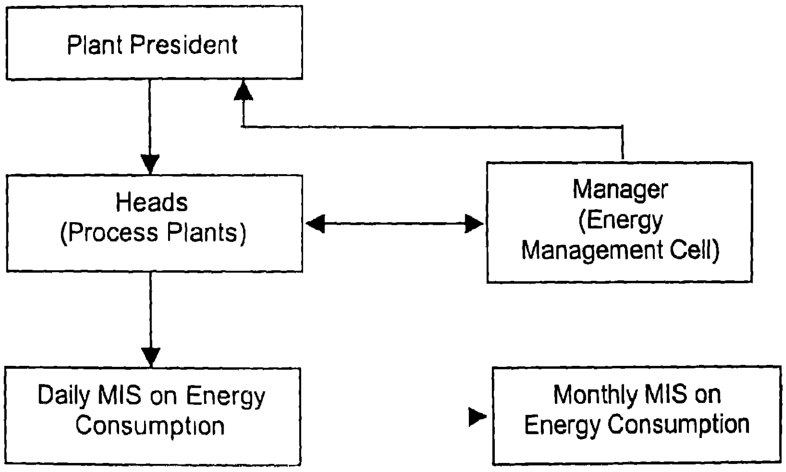
RIL (Reliance industries limited), Patalganga is located in Maharashtra. The facility at Patalganga produces PTA. The installed capacity of the PTA plant is 250,000 Tonnes per annum. The plant uses naphtha as feedstock and fuel. The plant process flow sheet is given in Annexure 6.3. The cost of energy for PTA is around 13% of the total cost of production. The plant had implemented a number of technical measures in past several years to bring down the energy consumption level. In fact, it has achieved energy consumption comparable to the international best practice levels.

6.4.1.1 Top management's commitments

Energy management is a critical focus of the top management and it participates on a regular basis in planning and review of various energy management projects. The annual reports of the company also give the details of energy management policy and projects. With regard to implementation of energy policy, a cross functional approach is followed wherein there is an involvement of different levels of management.

6.4.1.2 Energy Management Cell

The plant has separate energy management cell that looks after the issues related to energy conservation and energy efficiency. The primary function of the cell is to (1) monitor energy performance of the plant facility, (2) regular reporting of information pertaining to energy performance of the plant and various facilities to different level of management. (3) help in identification, execution and energy management projects. The organisation chart for the cell is given in Figure 6.4.1.2.


Plant President
Heads (Process Plants)
Manager (Energy Management Cell)
Daily MIS on Energy Consumption
Monthly MIS on Energy Consumption

Review: By Plant President, Heads (Process Plants) with Energy Manager

Figure 6.4.1.2 Energy Management Cell at a typical petrochemical plant

Daily monitoring of energy consumption is carried out in the plant. Energy cell monitors the specific energy consumption on a monthly basis. Monthly status reports on energy consumption is reviewed by the president in the presence of all plant heads. The department conducts in-house training program for workers and also interacts informally with other departments to motivate and identify opportunities to conserve energy. The energy management cell has full time personnel to look after various functions. The plant has also installed EMIS (Energy Management information system) to keep a close monitoring on the energy consumption. The energy management cell also helps in identify pollution prevention programs and implement the same.

6.4.1.3 Role of the energy manager

The energy manager acts as the driving force of energy conservation activities. He is responsible for monitoring and controlling energy consumptions. He is also responsible for implementation of energy conservation projects. As such planning monitoring and reviewing of such projects is done by him. Feedback on energy conservation activities to top managements is given by him. Finally he is also responsible for organising training programs, seminars that create awareness regarding energy conservation in the plant.

6.4.1.4 Initiatives to promote energy management

Plant conducts energy audits on a regular basis. However these audits are being carried out by internal auditors.

Employee motivation for energy management is through a suggestion scheme. Under this scheme, cash awards are given to individuals who recommend viable ideas that are implemented in the plant. Plant has implemented a lot of energy conservation measures over the years to progressively bring down the specific energy consumption.

Certain fixed hours of compulsory training are made mandatory for junior management. Generally these training's are in form of self study of training modules prepared inhouse. For mid and senior management, the projects act as a driver for bringing about technological and operational improvement. In these projects specific problems are taken up e.g. improvement in operational efficiency of a system, process optimization, reducing breakdowns etc. Various plant personnel are involved in selection of these projects. At the completion of these projects, findings are presented to various level of management.

The plant also conducts limited number of external training programs on energy efficiency. There is however no yearly training budget. However, these programmes are conducted as per requirement basis.

The plant reports and discusses various energy management achievements in internal newsletter/seminar.

6.4.1.5 Investment in energy conservation projects

Investment decision relating to energy management projects is taken by the top management. During annual budgeting there is a separate budget is kept for energy conservation. Investments in energy management projects are made on the basis of sound techno-economic analysis. The quantum of energy saved is an important criterion in decision making. For large energy management projects, approval is needed from top management.

6.4.1.6 Government policies

During the discussions it was brought out that the present government policies are conducive to promote energy efficiency in the industry and the policies would further accelerate energy management in the industry in general.

6.4.1.7 Barriers to implementation of energy conservation measures

The plant in general feels that there is no major barrier to implementation of energy conservation options at plant level.

6.4.1.8 Major issues for effective energy management policy

The foremost thing to promote energy conservation is the top management's commitment towards energy conservation. Strong commitment from top will ensure that energy management projects will get adequate support with respect to funds and manpower. Similarly, the motivation at lower levels to conserve energy will be high.

Within the organization of the company, an energy management cell headed by a full time energy manager will give impetus to energy management. To formalize the flow of energy information in the plant, a proper energy management information system (EMIS) must be put in place. The EMIS system can be integrated with existing systems to collect and collate data on energy management.

As part of energy conservation strategy, plant must adopt targets to reduce energy consumption. The targets can be set based on a mutual consultative process among working level managers, and all efforts should be made to achieve those targets.

6.4.2 Reliance Industries Limited (RIL), Hazira

RIL (Reliance industries limited), Hazira is located in Gujarat. The facility at Hazira produces a number of petrochemical products like Ethylene, Propylene, Benzene, POY, PP, PSF, MEG, PVC, VCM, Polyethelene, PTA etc. The plant uses several types of fuel like Naptha, LSHS, Furnace oil, Natural gas, coal etc. It has launched several initiatives to bring down the specific energy consumption. Plant had implemented a number of technical measures in past several years to bring down the energy consumption level.

6.4.2.1 Top management's commitments

Energy management is a critical focus of the top management and it participates on a regular basis in planning and review of various energy management projects. With regard to formulation of energy policy, a cross functional approach is followed wherein there is an involvement of different levels of management.

6.4.2.2 Energy Management Cell

The Energy management function of the plant is carried out by three different groups. The apex group comprising of Executive director RIL Hazira, President manufacturing, Vice President- E&FC, Vice President - CTS/TS. Then there is a core group which is comprised of Vice President-E&FC and the engineers of E&FC. Finally the working group is comprised of plant energy coordinators and Plant CTS/TS engineers.

The primary function of the working group is to (1) monitor energy performance of the plant facility, (2) create energy database. (3) help in identification, execution and energy management projects. The core group compiles and gives priorities to energy conservation schemes, provides guidelines in the functioning of the working group, arranges external energy auditors, aids in continuous bench-marking, and reporting data in the MIS. The Apex group regularly reviews complex energy consumption trend and provides major decision in implementation of energy conservation projects.

The plant head monitors the energy consumption of their respective plants on a daily basis. Weekly status reports on energy consumption are prepared for review by President-manufacturing. Fortnightly review of energy consumption and related activities are done by the apex group. The plant Executive Director monitors development of energy related activities on a monthly basis.

6.4.2.3 Initiatives to promote energy management

Plant conducts energy audits on a regular basis. These audits are being carried out both by internal and external energy auditors. The decision on external energy audits is taken by the core group.

Employees' motivation for energy management is promoted through a suggestion scheme. Under this scheme cash awards are given to individuals who recommend viable ideas that are implemented in the plant. Plant has implemented a lot of energy conservation measures over the years to progressively bring down the specific energy consumption.

The plant also conducts limited number of external training programs on energy efficiency. Plant personnel are sent for training programmes conducted by organisations like CII, FICCI etc. There are also regular interaction with the Licensors of the Technology to update information on latest measures adopted for energy conservation in other plants supplied by them.

6.4.2.4 Execution of energy conservation projects

The execution of energy conservation projects less than Rupees one crore is carried out at the plant level. Detailed engineering of projects worth about 100crore is carried out inhouse while for larger projects external consultants are hired for project execution. For all implemented projects a detailed review of actual and predicted gains are carefully analysed.

6.4.2.5 Government policies

During the discussions it was brought out that the present government policies are conducive to promote energy efficiency in the industry.

6.4.2.6 Barriers to implementation of energy conservation measures

The plant in general feels that there is no major barrier to implementation of energy conservation options at plant level. The plant has implemented several energy conservation projects which have helped the plant in reduction in specific energy consumption.

6.4.2.7 Major issues for effective energy management policy

The foremost thing to promote energy conservation in top management's commitment towards energy conservation. Strong commitment from top will ensure that energy management projects will get adequate support. Similarly, the high motivation at lower levels to conserve energy will yield results.

As part of energy conservation strategy, plant must adopt monitoring and target setting to reduce energy consumption. The targets can be set based on a mutual consultative manner and all efforts should be made to achieve those targets.

6.5 Issues to be stressed while framing the energy policies of the petrochemical industry

Petrochemical Industry is one of the most complex industrial sectors. The future of the industry depends in several factors and their interactions. Although the industry has seen a brisk rate of growth in the last decade, it has to gear-up to withstand global competition. The cost of domestic production remains high since many plants were set-up during a period of high customs and excise duties, high interest rates, poor infrastructure facilities, and administered pricing of raw materials.

Most of the petrochemical companies are already having excellent energy policies. However this does not imply that there is no further scope to improve the energy performance. The good practices being followed by petrochemical companies like energy policy, top management commitment, energy cell, small group activities, energy audit, target setting, and motivation have already been discussed based on the questionnaire survey and the meetings with individual companies.

Based on this discussion, the policy instruments possible for petrochemical industry have been divided into two categories - economic incentives to achieve energy efficiency and non-economic measures. A mix of policy instruments mentioned here needs to be used simultaneously to form an integrated policy for the sector.

6.5.1 Non-economic policy measures

6.5.1.1 Energy audits

Most petrochemical companies are already using energy audits. However, it is felt after discussions with plant management that decisions on issues such as frequency of energy audit, target setting, scope of work etc. are often taken on an ad-hoc basis. Streamlining the process of such energy audits, especially when involving external auditors is recommended.

There is also a lot of scope for strengthening the internal energy audit capability of the plants. Most plants even do not have the basic instruments necessary for conducting energy audits. Further, the engineers in energy cell have little experience or the time to devote to conducting energy audits. There is a large scope to strengthen the internal energy auditing capability of the plants in areas like instrumentation and strengthening of the human resources of the energy cell.

6.5.1.2 Monitoring

Most petrochemical plants are already doing regular monitoring of energy consumption trends. The latest plants are having distributed microprocessor based monitoring system. Few older plants however still have pneumatic instruments, and replacing them with DCS controls, will greatly help in identifying losses quickly so that remedial measures are taken immediately.

In addition to on-line monitoring, individual plants and energy cell also generate energy consumption reports. There is scope for rationalization of the plethora of energy consumption reports generated for senior management in some plants. Translating the deviations in actual performance from budgeted consumption into monetary value, if not done already, should be practiced.

6.5.1.3 Corporate strategy

In the long term, the achievement of energy efficiency will work best when energy efficiency considerations and investment are integrated into the day to day decision-making process at the firm, thereby reducing the amount of policy stimulus. Instead of making energy efficiency investments 'piggy-back' on other non-energy benefits like increase in production, firms will have to 'internalise' energy efficiency by adopting advanced technologies and innovative operating practices.

6.5.1.4 Training

Transformation of human capacity through training is a long-term approach to promote energy efficiency. Although most petrochemicals plant are conducting in-house training programmes and sending staff for external training, there seems scope for further improvement in this area. Two areas could be considered for giving a fillip to training of staff - making certain minimum hours of training compulsory for technical staff, and having a separate budget for training activities.

Certain fixed hours of compulsory training every year on energy management could be made mandatory for junior, middle and senior management personnel. For developing customized training modules, the head of the energy cell has to interact with the training or human resources development manager. In-house training facilities need to be strengthened in energy management, if required.

6.5.1.5 Management schemes

Most of the companies already have schemes such as suggestion boxes and energy conservation awareness programmes. There is a need to promote these schemes in an innovative manner so that employees at all levels are motivated to participate. Also, formation of cross-functional groups of employees to identify new energy conservation projects, should be encouraged and if possible be made mandatory for junior and middle management levels. Over and above the routine projects undertaken by the energy cell and technical services.

6.5.1.6 Economic policy measures

a. Subsidies (hardware, instruments)

Subsidizing of energy efficient equipment, and monitoring and audit instruments will promote energy conservation in the sector. Government has a role to play in publicizing the existing subsidy schemes available for hardware as well as reviewing and updating such schemes on a periodic basis.

b. Tax structure

The import tariffs on petrochemicals are being steadily lowered every year since the start of liberalization. The threat of international competition has thus increased due to reduction in import duties. The import duties have been gradually reduced from about 150 per cent in 1990s to just 15 percent or so. But because of several reasons such as higher local feedstock prices and higher cost of capital, the prices of domestic products are higher than imports posing a serious threat to the industry.

One strategy could be adequately differentiate in the duty structure between raw materials, intermediates and final products with lowest rate of import duty on raw materials and finished products attracting higher duty with a view to encourage manufacturing activity and higher value addition in the country.

c. *R&D subsidies*

The petrochemical industry is technology driven. Although original research in petrochemical manufacturing process is very expensive, there is scope to promote indigenous R&D capabilities, in niche areas such as catalysts, instrumentation, energy efficient devices etc by subsidising R&D expenditure. However the present R&D expenditure by domestic petrochemical firms is much lower compared to international level. Government has many schemes to promote indigenous R&D such as 100% depreciation on the expenses during first year itself. There are also custom and excise duty subsidies for R&D institutions. Such concessions may be extended to industrial R&D also. Information dissemination of existing subsidies among domestic industry needs to be promoted. Analysis of the adoption of existing schemes by the industry and review to make them user-friendly is required.

d. *Institutional change*

A key to competitiveness in petrochemical industry is the size of plants. Some of the petrochemical plants and especially downstream processing units have small sized plants and consequently are not able to reap the benefits of economies of scale. To make themselves competitive, the units will need to enlarge their capacities.

There is also a need to focus on infrastructure development in terms of raw material handling, port and jetty facilities, pipelines for bulk transportation and power supply for increased competitiveness of domestic petrochemical industry.

6.6 .References

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Annexure 6.1

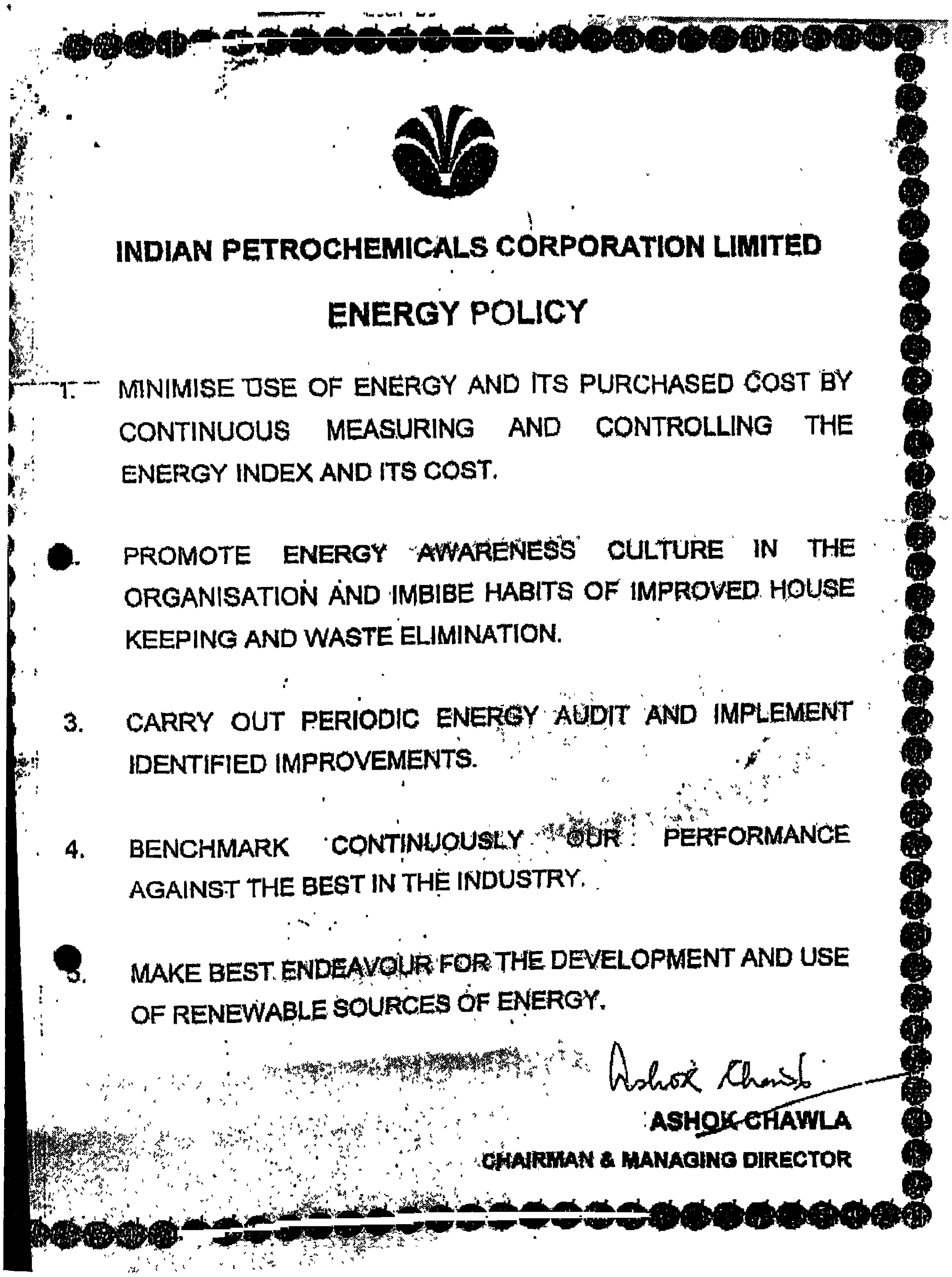
Summary of date collected from plants

Sl. No.	Description	Units	Year 1	Year 2	Year 3
1	Products				
	PTA	MT	229104	263939	265222
	Product n				
	Installed Capacity	MT	250000	250000	250000
	Product 1				
	Product n				
	Actual Production				
	Product 1				
	Product n				
2	Specific Energy Consumption				
	Electrical SEC	kWh/ton	160	279	265
	Thermal SEC	Ton of steam/ton of PTA	3.528	1.894	1.568
3	Energy Consumption and Cost				
	Electrical	NA	NA	NA	
	Thermal	NA	NA	NA	
4	Energy Conservation Measures				
	Measures				
	▪ Implementation of PTA plant debottlenecking projects resulting in low pressure operation of the reactor leading to power and steam saving in process air compressor				
	▪ Reuse of second crystalliser flash steam for preheating slurry water				
	▪ Cooling water circulation pump and fan stoppage after optimizing PTA plant cooling water consumption				
	Investment	500lacs	5lacs	0	
	Savings	2441 lacs	127 lacs	173	

Sl. No.	Description	Units	Year 1	Year 2	Year 3
5	Organisational Structure of the EM cell				
	EM Cell	Yes			
	Energy Manager	Yes			
	Energy Audit	Yes			
	Energy Management Policy	Yes			
	Environment Policy	Yes			
	Quality Policy	Yes			
6	Sector Specific details if any				

Annexure 6.2

Energy policies



INDIAN PETROCHEMICALS CORPORATION LIMITED

ENERGY POLICY

1. MINIMISE USE OF ENERGY AND ITS PURCHASED COST BY CONTINUOUS MEASURING AND CONTROLLING THE ENERGY INDEX AND ITS COST.

[illegible]. PROMOTE ENERGY AWARENESS CULTURE IN THE ORGANISATION AND IMBIBE HABITS OF IMPROVED HOUSE KEEPING AND WASTE ELIMINATION.

3. CARRY OUT PERIODIC ENERGY AUDIT AND IMPLEMENT IDENTIFIED IMPROVEMENTS.

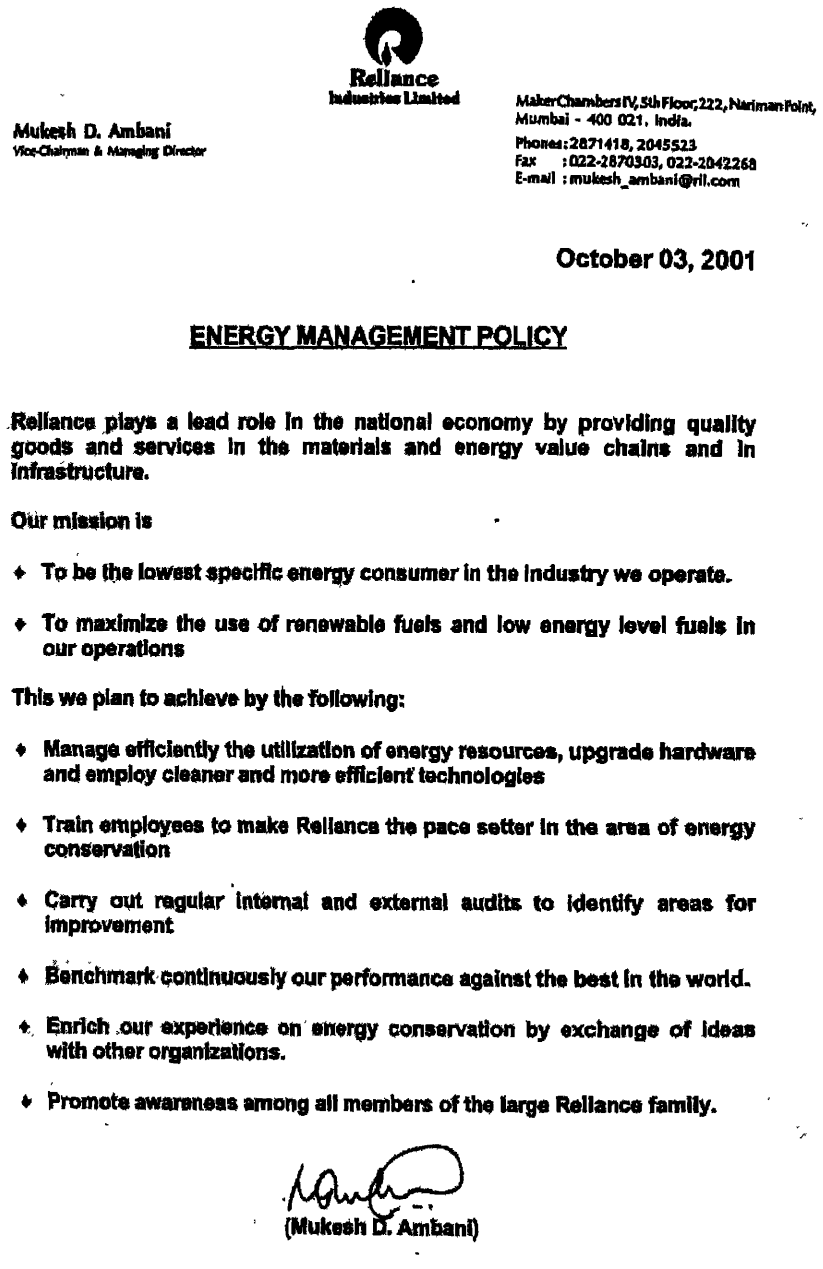
4. BENCHMARK CONTINUOUSLY OUR PERFORMANCE AGAINST THE BEST IN THE INDUSTRY.

5. MAKE BEST ENDEAVOUR FOR THE DEVELOPMENT AND USE OF RENEWABLE SOURCES OF ENERGY.

Ashok Chawla

ASHOK CHAWLA

CHAIRMAN & MANAGING DIRECTOR



Reliance
Industries Limited

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Vice-Chairman & Managing Director

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October 03, 2001

ENERGY MANAGEMENT POLICY

Reliance plays a lead role in the national economy by providing quality goods and services in the materials and energy value chains and in Infrastructure.

Our mission is

- **To be the lowest specific energy consumer in the industry we operate.**
- **To maximize the use of renewable fuels and low energy level fuels in our operations**

This we plan to achieve by the following:

- **Manage efficiently the utilization of energy resources, upgrade hardware and employ cleaner and more efficient technologies**
- **Train employees to make Reliance the pace setter in the area of energy conservation**
- **Carry out regular internal and external audits to identify areas for improvement**
- **Benchmark continuously our performance against the best in the world.**
- **Enrich our experience on energy conservation by exchange of ideas with other organizations.**
- **Promote awareness among all members of the large Reliance family.**

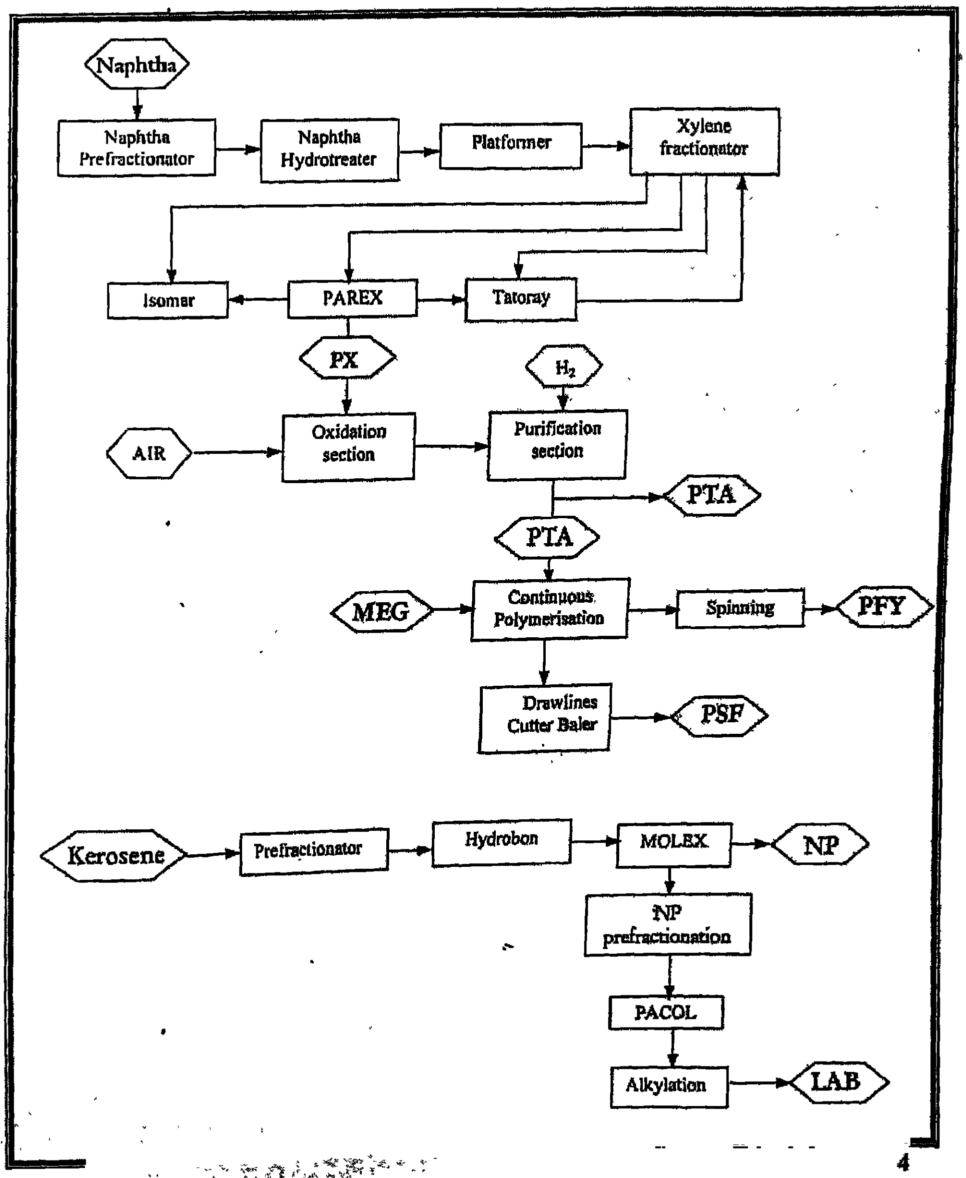
(Mukesh D. Ambani)

Annexure 6.3

Profess flow sheet for Reliance Industries Ltd, Patalganga

RIL-PG

8. SCHEMATIC DIAGRAM FOR PRODUCTION PROCESS :



7

Pulp & Paper Industry

7.1 Profile of the industry

The Indian paper industry accounts for about 1% of the world's production and expected to grow with an annual rate of 7% in near future. There are 515 registered pulp and paper mills in India, with an estimated installed capacity of about 5.4 million tons for paper and 1.7 million tons for newsprint. Domestic paper demand has increased form 4.0 million tons in 1996-97 to 4.8 million tons in 2000-01 at compound annual growth rate (CAGR) of 4.8% for the last four years. The demand for newsprint has increased from 0.7 million tons in 1996-97 to 0.9 million tons in 2000-01 with a CAGR of 6.7%. The paper production in 2000-01 was 4.8 million tons where as the newsprint production was 0.6 million tons in the same year. This sector provides employment to around 3.5 million people directly and indirectly. The paper consumption in India is about 5 kg per capita as against of world average of 50 kg.

Based on the installed capacity, the Indian mills are categorised into two types: large (>100 TPD) and small (<100 TPD) mill. The paper mills can also be classified on the basis of raw material- wood based (39%), agricultural residual waste (33%) and waste paper based (28%). Small mills account for more than 50% production capacity with poor energy and environment performance level. The average production capacity of Indian paper plant is around 10500 tons per year.

The paper mills, which are in existence today, have been installed over a span of more than 100 years and, hence, present technologies are falling in a wide spectrum ranging from oldest to modern. Being protected from international competition for about four decades, Indian paper mills, in general, did not keep up with the technological advancement in the other part of the world. Few large paper mills have implemented new technologies because of high product and social costs, availability of cheaper final and intermediate products in international market, international competition, mounting pressure from environmental regulatories, rise in energy prices, etc.

Salient features of Indian paper industry

- Produces 1% of the total world's production
- 515 registered mills
- Installed capacity (2000-01)
    - 5.41million tons for paper
    - 1.1 million tons for newsprint
- Total production (2000-01)
    - 4.65 million tons of paper
    - 0.46 million tons of newsprint
- Paper consumption per capita in India is about 5 kg
- Expected growth rate is 7% in near future
- Average plant capacity is 10,500 tpa.
- Consumes 7% coal and 3% of electricity produced
- Energy consumption levels are about 50% higher than that in developed countries
- Energy cost is 20-25% compared to 12-15% in developed world
- Low scale of operation
- Old technology
- Low penetration of energy efficient and environmentally sound technologies
- Labour intensive with low specific production
- Scarcity of large fiber raw material in the country
- Financial constraints for implementing energy efficiency improvement measures

7.1.1 Questionnaire Analysis

A total of 60 paper plants are having the capacity of 50 TPD or more were shortlisted for sending the questionnaire. A broad spectrum of paper plants at different geographical locations manufacturing different products such as industrial, kraft and specialty paper were identified for mailing the questionnaire. 22 plants having different capacities and products have responded. Those who have responded are having the production capacity in a range of 60-600 TPD and are manufacturing writing and printing paper, kraft paper, newsprint, boards, specialty paper, etc. A variety of raw materials such as wood, bamboo, agro-waste, waste paper, etc are being used for papermaking. A summary of data collected from different plants is given at Annexure 7.1.

7.2 Analysis of Part A (Quantitative details) of questionnaire

7.2.1 Installed capacity and capacity utilisation

The companies responded, are having the installed capacities in a range from 50 tpd (15000 tpa) to 600tpd (180,000tpa). The vintage of the plants varies from 6 years to 65 years. The oldest paper mill is commissioned in 1936 whereas the latest one is in 1996. The capacity utilisation of these mills is shown in figure 7.2.1 for the years 1998-99, 1999-00 and 2000-01. It is clear from the figure that some of the mills have achieved the capacity utilisation well above 100% whereas some of them operating at about 50% only. One of the mills didn't provide the latest production figure. Lower capacity utilisation is one of the reasons of higher energy consumption of the plant.

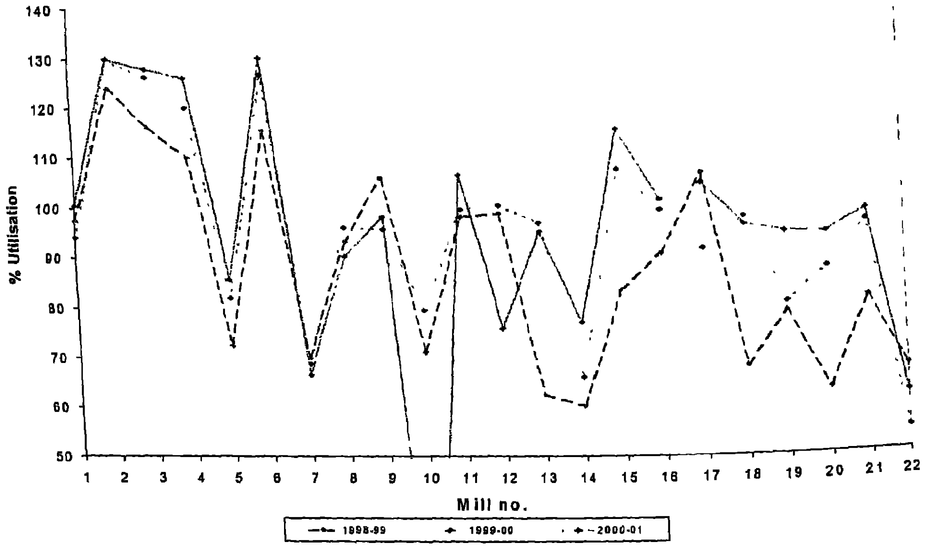


Figure 7.2.1 Capacity utilisation

7.2.1.1 Raw material usage

A variety of raw materials are used in paper industry. Normally, a mix of material is used for production. It depends on regions, type of product manufactured, cost of the raw material, etc. Types of raw materials consumed by the mills who replied the questionnaire, are hard wood, bamboo, reed, bagasse, rice straw, wood pulp, imported pulp, waste paper, jute, cotton linters, paper cuttings, etc.

7.2.1.2 Product type

The paper mills, under the study, are producing a wide range of paper, which could be classified under two broad types.

- Paper and paper board
- Newsprint

Paper and paperboard can be further classified into industrial grade and cultural paper. Industrial grade paper includes specialty paper, wrapping and packaging paper. Cultural paper includes writing and printing paper. MICR, tissue, copier, poster, etc are the types of the specialty papers. Most mills have license to produce both writing and printing paper, and newsprint, and they switch from paper to newsprint or vice-versa, depending upon the market situation.

7.2.2 Fuel Usage

The main fuel used in the industry is coal, which is about 60-70% of all fuel usage. Coal is used to produce steam, which is the most important medium of heating in pulp mills. All large pulp and paper mills and many medium sized agro paper mills have cogeneration facilities and use steam turbines to generate the electricity. The exhaust steam from turbines is used for process heating. Other fuels such as low sulphur heavy stock (LSHS), furnace oil, rice husk, pith, etc. are also used to fire boilers. Light diesel oil (LDO) and high-speed diesel (HSD) are used for captive power generation in diesel generator sets in these plants. All large and medium sized plants are also using recovery boilers to generate steam from black liquor, which can provide up to 30% of the total energy requirement.

7.2.3 Technological status

The paper mills which are in existence today, have been installed over a span of more than 100 years, and hence practice technologies falling in a wide spectrum ranging from old to modern. Several large integrated mills came on stream during the late 1970's but the growth, apart from the expansion of existing capacity, has mainly been the result of creating new small mills. The average size of paper mills in India is now about 10500 tpa (35 tpd) compared to 85,000 tpa (260 tpd) in Asia and 300,000 tpa (900 tpd) in Europe and North America.

Most of the machinery installed in Indian paper mills are imported from overseas. The new technologies like continuous digestors, high-speed paper machines etc. with sophisticated instrumentation are supplied to Indian industry by reputed foreign manufacturers in collaboration with the local machinery manufacturers. Adequate expertise has been developed in the country to supply auxiliary machinery like power boilers, chemical recovery boilers and turbines indigenously. Since many of the older plants have machinery which were installed 20-30 years back, considerable modernisation and technology upgradation is required to gain the benefits of latest developments in controls & instrumentation, and process technology.

Shortage of conventional raw material such as bamboo and wood has been cited as one of the major reasons for the decline in the capacity utilisation. In fact, lower capacity utilisation has been endemic to the industry and more than 100 paper mills have been sick and lying closed for the last 15-20 years. The total capacity of the closed units is about 1 million tons per annum. An upward trend is witnessed from 1994-95 due to demand growth in the domestic market.

7.2.4 Energy performance

The paper industry is highly energy intensive. This industry is ranked sixth largest energy consumer in the country and account for 7% of country's coal and about 3% of the electrical energy requirement.

The share of energy consumption as percentage of manufacturing cost for the year 2000-01 is shown in the figure 7.2.4. It is clear from the figure that the share of energy in the manufacturing cost for most of mills which responded, falls in the bracket of 20-30% with an average of 25% for all the mills. There are few mills having the share of energy cost about 10-15%. There are many factors on which the energy consumption depends. Major contributors to this are the type of product and the raw materials used for it. Product like kraft, boards, etc requires lesser energy for their production, whereas specialty paper consumes more energy per ton of production.

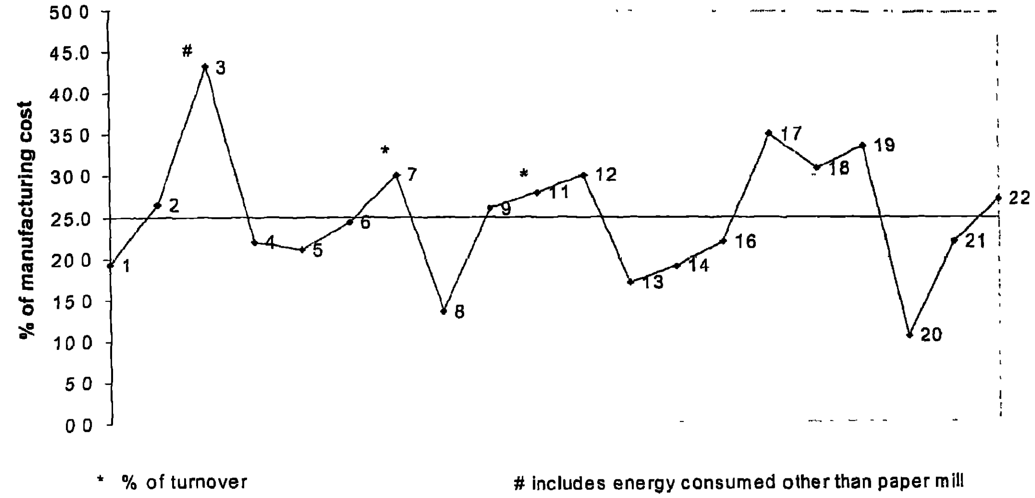


Figure 7.2.4 Energy share of manufacturing cost

Similarly, use of pulp and waste paper as raw material need less energy input compared to hard wood to produce one unit of the product. Other factors contributing to specific energy consumption are plant vintage, capacity utilisation, etc.

7.2.5 Specific energy consumption

7.2.5.1 Steam

Figure 7.2.5.1 shows the comparison of steam consumption per ton of paper produced for the paper mills for the year 2000-01. The average of all the specific steam consumption figures is 9.86 ton of steam per ton of the product. This figure varies in a great range from as low as 2.2 for the mill#10 to 21.76 ton of steam per ton of product for mill#19. This large variation is due to different raw materials used for manufacturing different products, vintage of plant, capacity utilisations, etc. Figure 7.2.5.1 also shows the upper and lower limits of steam consumption per ton of products which is equivalent to average steam consumption i.e. 9.86± 30%. It is clear from the figure 7.2.5.1 that most of the mills fall between the upper and lower limits, but still a good number of mill falls beyond the limits. The mills falling lower than the lower limit essentially make low value added products like kraft, boards, newsprint, etc. and the major raw materials used are waste paper, imported pulp, agricultural residue, wood pulp, etc. However, mills consuming the steam more than the upper limit are mainly manufacturing writing & printing paper and other high specialty products like

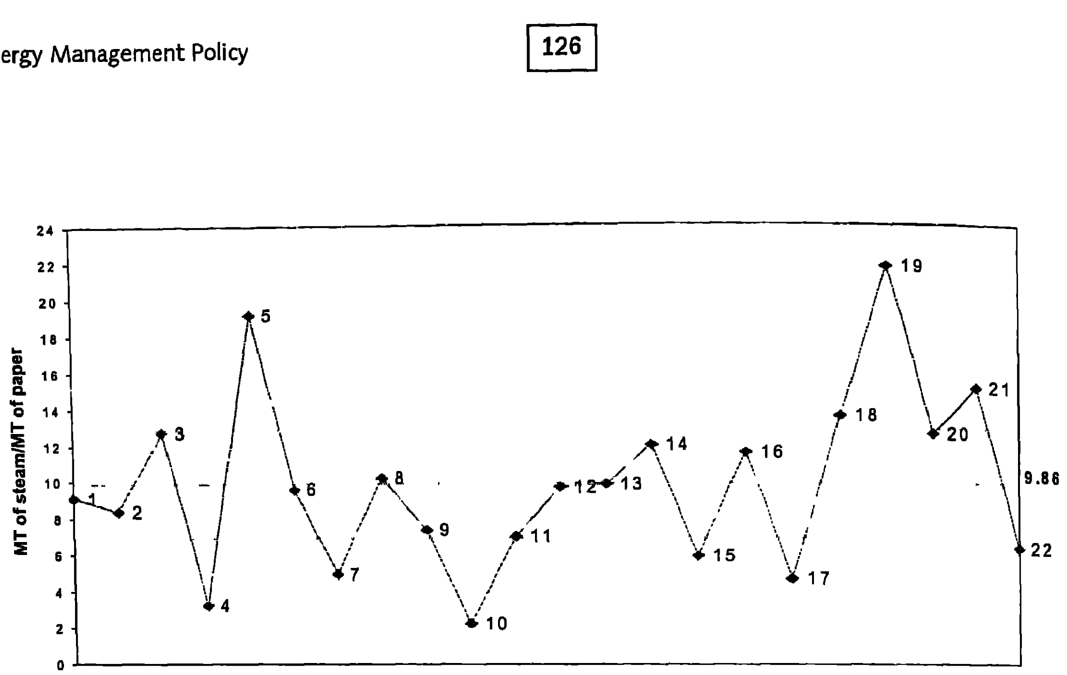


Figure 7.2.5.1 Plant-wise specific steam consumption

poster, tissue, creamwove, MICR cheque paper, etc. Main raw material for this is hard wood. Steam consumption in mills #5 and #19 is reported to be very high which may be due to steam supply for some purpose other than paper production. Some of the reported steam consumption figures by paper mills seem to be not correct and therefore have been reworked with the help of fuels consumed in the plants.

7.2.5.2 Electricity

Plant wise electricity consumption per ton of paper for the year 2000-01 is shown in figure 7.2.5.2. The consumption varies from 613 units per ton of product to 2072 units per ton of product. The average consumption is 1420 units per ton. It is evident from the figure 7.2.5.2 that maximum number of specific

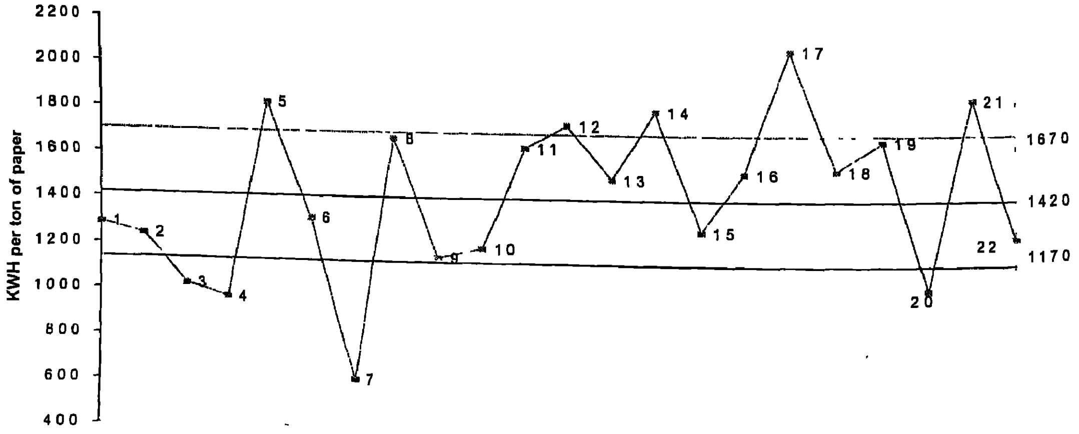


Figure 7.2.5.2 Plant-wise specific electricity consumption

electricity consumption values fall within the range of 1420±20% units. These values also depend on the factors discussed in earlier paragraphs. Much lower consumption in plant #7 is because of the maximum use of waste paper as raw material for manufacturing the craft paper, which requires lower energy per ton of product. All the plants near upper limit and beyond are ones using hard wood and bagasse as major raw material for production.

7.2.6 Energy consumption norms

Confederation of Indian Industries (CII) had conducted a study to evolve specific energy consumption norms for different types of paper and sizes of the mills. A summary of the norms proposed by CII is reproduced in table 7.2.6.

Table 7.2.6 Product-wise energy consumption norms

Mill type	*Steam consump. (t/t of finished product)*	*Power consump. (kWh/t of finished product)*
Writing & Printing Paper		
Large integrated mills (near 100% wood pulp based-sulphate process)	9.00	1400
Small and medium mills (agro based)	5.75	1200
Small and medium mills (waste paper based)	2.80	700
Kraft		
Large integrated mills (sulphate process except bleaching)	8.60	1280
Small and medium mills (agro based - 65% bagasse, 10% gunny & 25% waste paper-unbleached kraft)	4.10	650
Small mills (waste paper based)	2.30	550
Board		
Large integrated mills (60% waste paper & 40% hard wood)	7.00	1175
Medium mills (waste paper based)	2.20	615
Small mills (waste paper based)	2.40	685
Newsprint		
Large integrated mills (with 100% wood pulp)	4.72	2230
Large integrated mills (with 20% imported pulp)	4.72	1825

7.2.7 International comparison

Energy efficiency of a typical Indian mill is much lower compared to its counterparts in the developed countries owing to old technology base. Absence of modernisation at an aggregate level has reflected in poor energy efficiencies vis-a-vis mills in developed countries. The average energy cost for Indian paper mills is around 20-25% of total production cost, as against 12-14% in the USA, Sweden, Finland and other major paper producing countries.

By adoption of new technologies, mills in developed countries have been able to reduce their consumption of fossil fuels. Sweden, which has reduced the oil consumption in the industry by 70%, over the past decade (1980-90) tops the list, followed by Japan (34%) and UK (8%). On an average, steam consumption per ton of paper is 6.5 - 8.5 tons whereas electricity consumption is 1150-1250 kWh, in mills abroad. With the above comparison, it is clear that there is a large scope of energy conservation in Indian pulp and paper industry.

7.2.8 Major energy saving measures implemented in the industry

Major energy conservation measures implemented in the industry is given in Annexure 7.2, and the energy management policy statement and the organisation chart of some of the industry is given at Annexure 7.3.

7.3 Analysis of Part B (Energy management practices) of questionnaire

7.3.1 Energy/Environment/Quality policy

Most of the plants that responded, don't have the formal energy policy (Figure 7.3.1). However, all of them have the environmental and quality policies. These are also displayed prominently inside the plant as well as at plant gate for the general public. Those plants having the formal energy policy have also displayed it publicly. Few plants have informed that they are in process of formulation and it will take some times to come out as a document. Energy policies of some of the paper plants are given in Anexure 7.3.

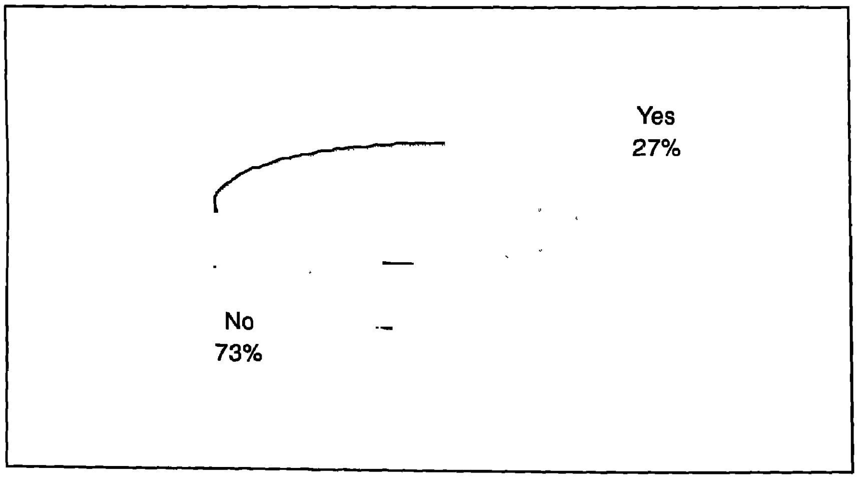


Figure 7.3.1 Formal energy conservation policy

7.3.2 Commitment for energy conservation

Though most of the responding paper mills don't have the formal energy policy but still they are actively involved in energy conservation, and the energy management is the critical focus of the top management. Top management of the company participates in planning and review of various energy management projects on a regular basis. The annual reports (Figure 7.3.2) of the many companies mention the details of energy conservation activities and various achievements by the company regarding the energy conservation projects.

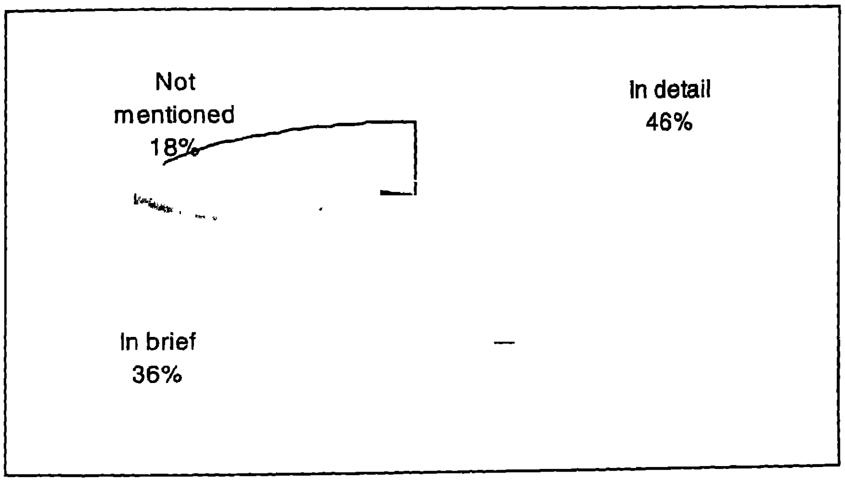


Figure 7.3.2 Highlights of energy conservation in annual report

7.3.3 Energy management cell, its organisation and role

Paper plants understand the importance of energy conservation and to perform this function, energy management cell (EMC) has been constituted. Almost all-large paper manufacturing plants have it (Figure 7.3.3a). It has members drawn from various sections of the plant who have been given additional responsibility of energy conservation other than to their primary jobs related to production. Few companies also have one or two members permanently placed in energy

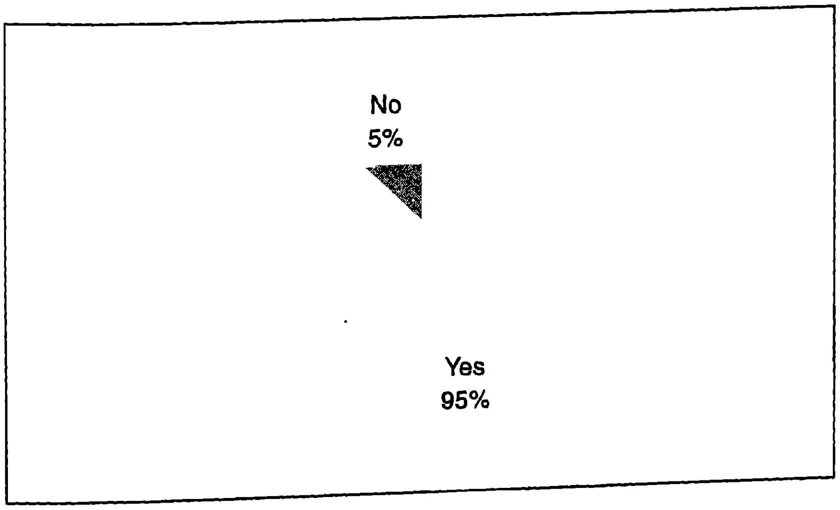


Figure 7.3.3a Energy Management Cell in plant

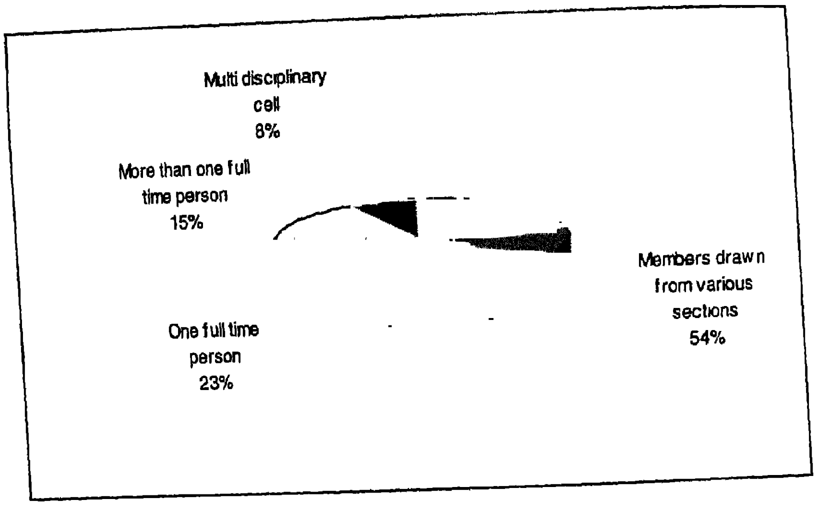


Figure 7.3.3b Structure of Energy Management Cell

management cell as core members and other members are drawn from the other sections (Figure 7.3.3b). Each member is responsible for energy related activities in his area. The posting in energy management cell is on a rotation basis to increase the awareness and commitment of the plant personnel. The other benefit, of this, is improved cross-functional integration in the company. The deputation to the cell is about 1-4 years.

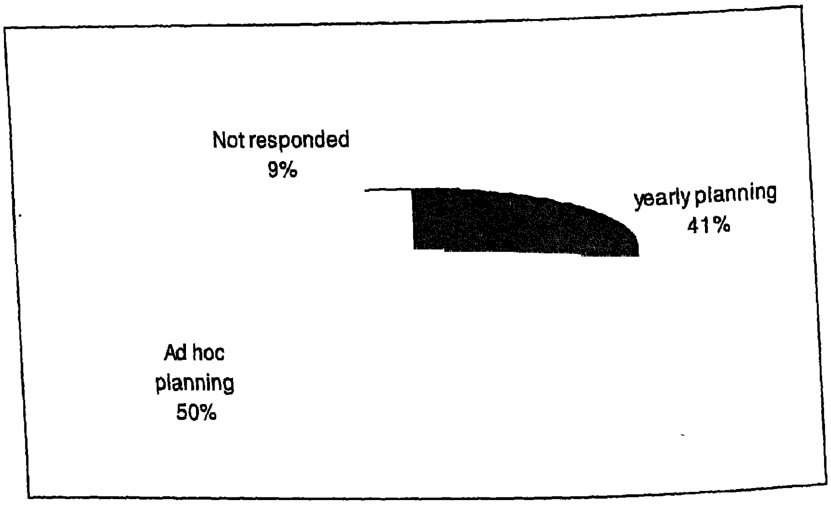


Figure 7.3.3c Energy conservation planning

The job of EMC is to generate the energy management plan, energy budget, etc for the company in a year in advance (Figure 7.3.3c). It is based on the last year's consumption and the energy conservation initiatives taken by individual sections. EMC also carry out discussions with various department of the plant to identify or generate ideas for energy saving on routine basis. After analysing the preliminary idea on cost benefit basis, it came out during the discussion, EMC

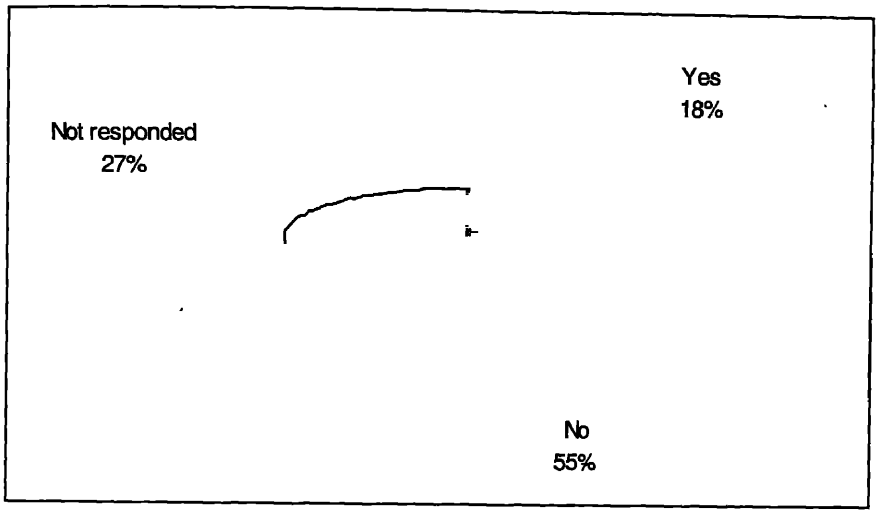


Figure 7.3.3d Board member with the responsibility of energy conservation

implement it if it is found feasible. The actual benefits of doing this project are assessed by continuously monitoring its performance. The EMC also prepares comprehensive energy consumption status report of the plant duly subtracting the energy savings due to various project which will act as a base line for the next year's energy budgeting.

The cell also conducts internal training programme or campaign to create awareness among the plant personnel. Help of some external faculty is also availed for this purpose. Similarly, pollution-reducing measures are also identified and implemented with the help of interaction with various departments. To further smoothen the function of EMC, few companies have included one of the board members in the cell. It also shows the commitment at higher level towards these activities. Typical structures of energy management cells at two paper plants are given in Annexure 7.4.

7.3.4 Small group activities

Most of the paper mills, responded to the questionnaire, regularly carry out such activities (Figure 7.3.4a). These are carried out at various levels from shop floor to top management level.

The frequency of the meeting (Figure 7.3.4b) depends on the level of participation which varies from once in a week to quarterly. Few plants organise

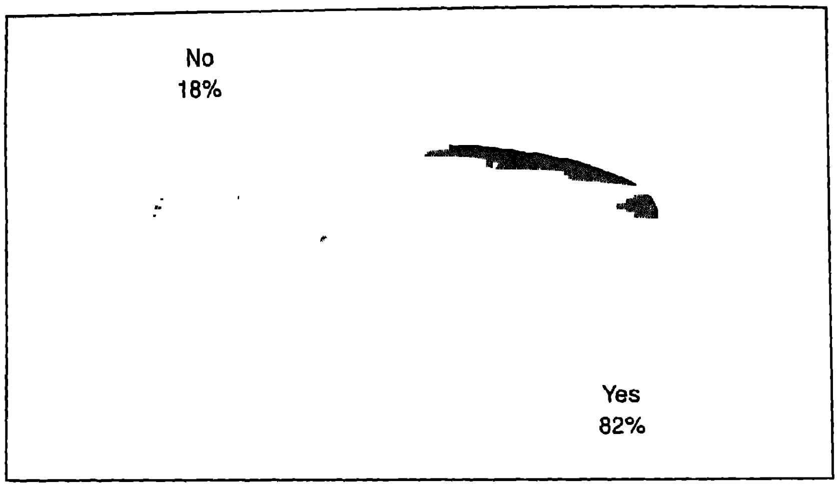


Figure 7.3.4a Small group activity

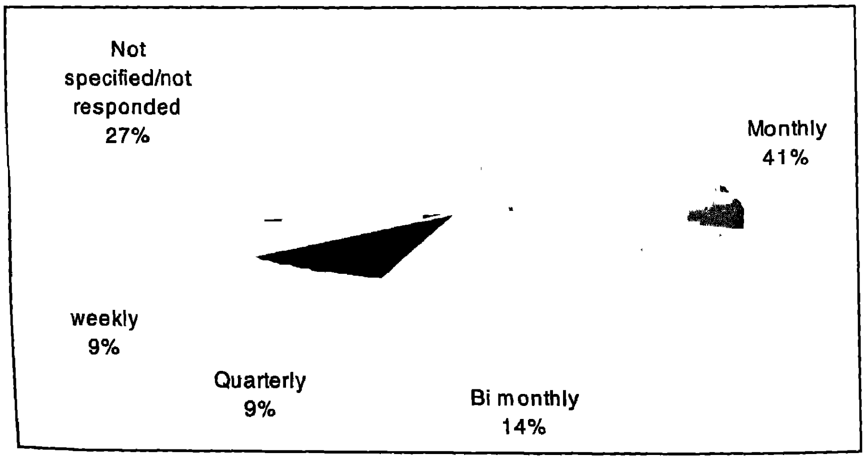


Figure 7.3.4b Frequency of meetings

as and when it needed. As per the feedback this activity help in generation of ideas and thereby improving the plant performance by implementation of these. This platform is used for creating the awareness, discussing the ideas and reviewing the activity and achievements in the department.

7.3.5 Role of energy audit

Almost all of the paper mills that responded, are conducting energy audit in their plant (Figure 7.3.5a). These are conducted internally and externally. In-house energy audits are more frequent and it is the regular activity in the plants.

Frequency of the energy audit by external agency varies from once in a year to two years (Figure 7.3.5b). Some of the mills depends on external energy audit

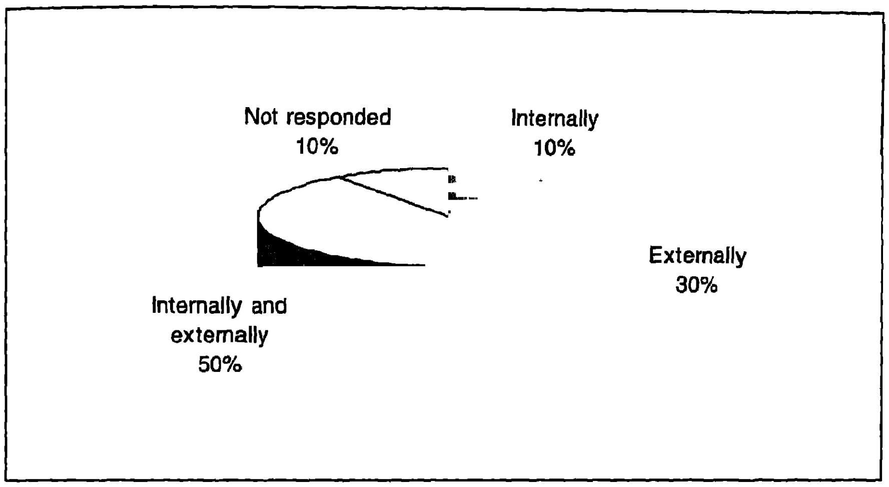


Figure 7.3.5a Energy audit

only and don't undertake routine internal audit. There are also few paper plants that take up external study after a long gap or as and when need arises. Major recommendations evolving from the audits are implemented and outcome monitored by energy cell.

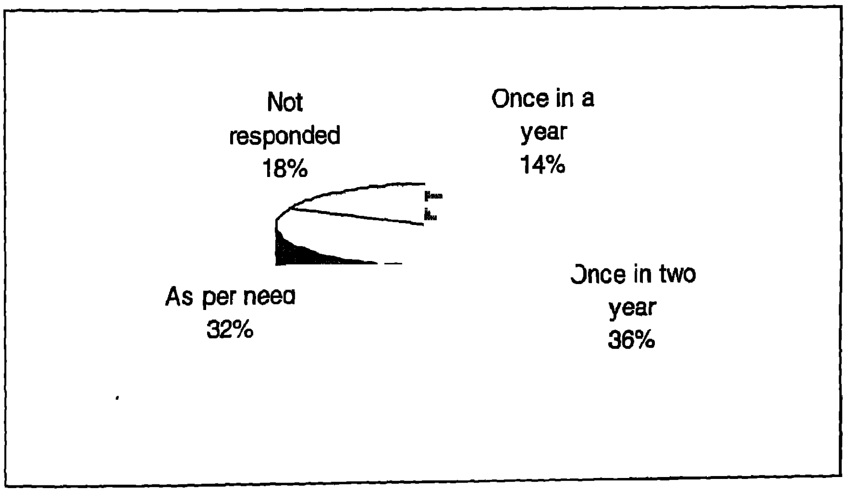


Figure 7.3.5b Frequency of energy audit

7.3.6 Energy conservation budget

In the questionnaire survey it was noted that many paper companies have a separate budget earmarked for the energy conservation/management activities in every financial year (Figure 7.3.6). But in most of the paper mills, who responded, the decision making on energy investment is centralised and it is decided at top management level. These decisions are taken based on the techno-economic analysis and return on investment is an important criteria.

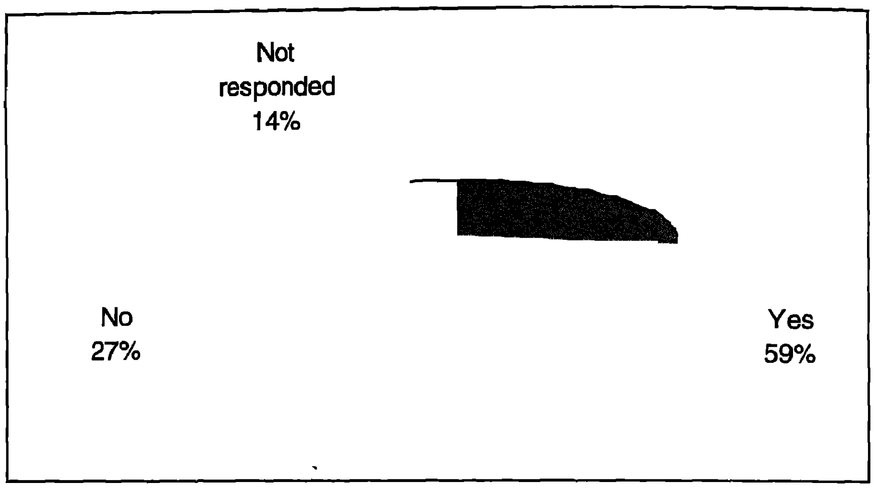


Figure 7.3.6 Separate budget for energy conservation

7.3.7 *Targeting and energy budgeting*

The target for energy conservation or the energy budget is, normally, planned for every year in advance in paper industry. Some units also plan for long-term. The long-term planning, generally, consists of either large investment or adopting renewable energy sources. These guidelines are framed at the year start and all departments try to achieve it. Energy consumption during the previous year is the starting point, and the next year's target are set on the basis of average of few best figures (daily or monthly) of last year. Few paper mills take the lowest monthly average figures of energy consumption for setting up their next year's target. Best specific energy consumption figures in this sub-sector are also considered for bench marking for the successive rear by few companies.

7.3.8 *Motivation*

There are a number of schemes in paper mills to educate and motivate the plant personnel. All employees are encouraged to participate in such schemes. The most common schemes prevailing in paper plants, are slogan and suggestion schemes. Inplant training (Figure 7.3.8) is also imparted to the employees on the subjects related to energy conservation to improve their awareness on energy related issues. Outside faculty are also called for if needed for such programmes. Selected people are also sent to attend the training programmes, workshops, etc. Few mills have annual budget for training the employee including the external training programmes, workshops, etc. Some of the mills, also, encourage its employees to publish energy management achievements in journals. These are also reported in the internal newsletters.

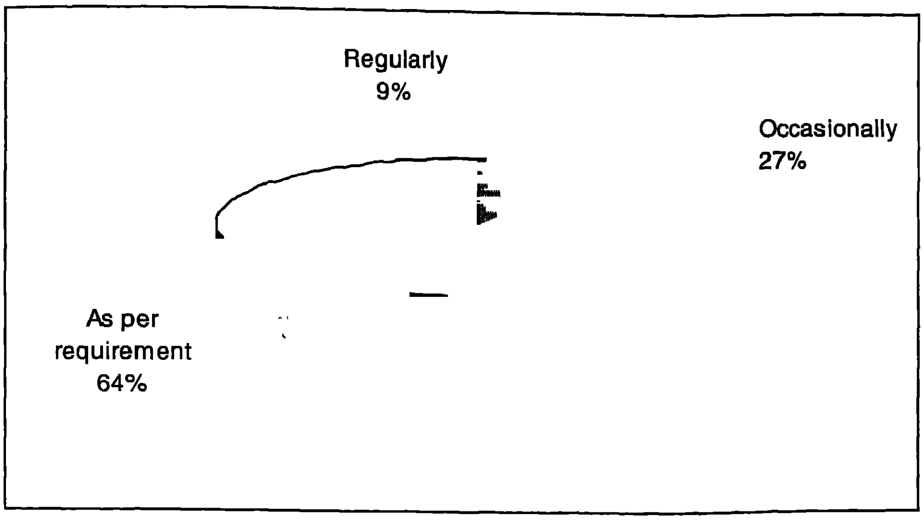


Figure 7.3.8 Training of plant personnel

7.3.9 Barriers for energy conservation

The problem in adopting latest technology, available readily in world market, is its larger size (capacity constraint of existing plants), which normally does not suit to smaller sized Indian plants. The suppliers have to fabricate lower size tailor-made equipments according to Indian paper plant capacity, which does not fit to their normal practices. As they have to manufacture special machinery, the cost of these equipments is unproportionately higher.

Another barrier is the unavailability of capital at lower cost. Usually soft loans are not available to the paper mills for energy efficiency project. Loans wherever available are at normal interest rates ranging from 12 – 15 %. This in turn makes the cost of servicing the debt high. The small size of firms, in some segments of the industry, prevents it from utilizing the loans. There is a tendency to minimize the capital cost of any project in order to avoid a huge debt. Hence energy inefficient processes which usually have lower capital cost and higher operating costs find favour in Indian paper industry.

Few paper mills feel that installing energy conservation equipment may lead to production disruption. Production is like a sacred thing in the plant and no one will favour it to stop in normal condition.

Very few paper plants feel that there is hardly any constraint and any determined mill, for energy conservation, can do it at any time. They also feel that money is available in financial market and one has to prepare the project report accordingly.

7.3.10 Government's Policies

Energy conservation is a high priority area for Govt. of India (GoI) especially in light of acute power shortage being witnessed since past few years. In an effort to increase the pace of industrial energy conservation, GoI has announced a number of policies and schemes. Most of the paper mills (Figure 7.3.10) are either not aware of these schemes or have not availed the concession because of bureaucratic procedures. It is felt that concessions are need to be highlighted properly and the procedures to be made more simplified in order to make them more industry friendly.

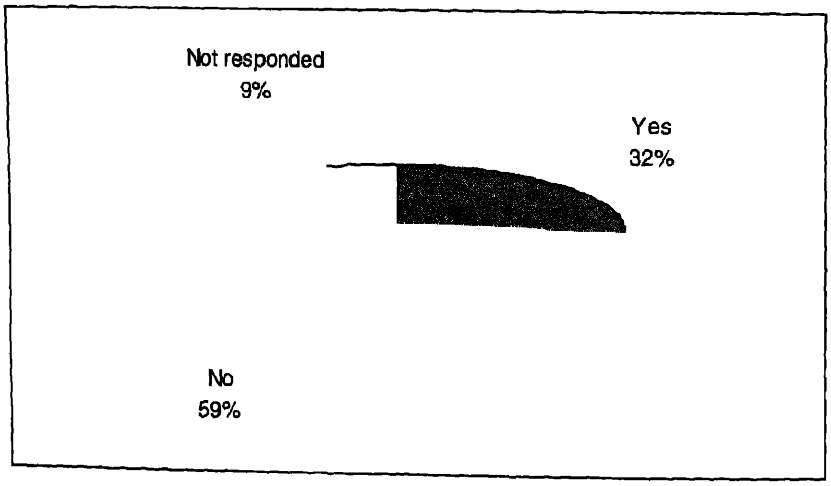


Figure 7.3.10 Favourability of government's Policy

The respondents from the paper industry are in favour of financial concessions and easier financing options like - low interest financing, rebate in custom duties for importing energy efficient equipments, tax credits for energy efficient investments and accelerated depreciation. There was however no clear preference among the financial concessions in the industry. Also industry generally prefers lesser bureaucratic procedures for availing of energy conservation benefits.

Paper industry is also in favour of more demonstration plants and support for R&D activities. It is also felt that the awareness on energy conservation should begin at the school level to give better understanding to workers who join industry after school.

Better standards for energy consuming equipments are highly recommended to reduce energy consumption which are generally not available. The main problem appears to be non-existence of norms, lack of after sales service and unreliability of equipments. It is, therefore, recommended to adopt a policy towards the manufacture of equipment required for promoting greater energy efficiency.

7.4 Field visits

7.4.1 Ballarpur Industries Ltd., Yamunanagar

Ballarpur Industries Ltd. (BILT) is a flagship company of the Thapar group. BILT is the leader of pulp & paper industry in India. The company manufactures around 18% of the country's total production. Their unit, Shree Gopal Mills located at Yamunanagar, contributes about 30% of the total paper manufactured by the group. Yamunanagar plant produces writing & printing paper, coated paper and other specialty papers. The installed capacity of the plant is 70000 tpa. The capacity utilisation of the plant is above 100%. The unit has 3300 employees and produced 70273 MT of paper during 2000-01. A variety of raw materials are used for production. These are hard wood & wood waste, bamboo, agricultural residue, waste paper, etc. Sales turnover of the unit during 2000-01 was Rs. 487.38 crores.

The plant has continuously improved its performance over the years and achieved higher capacity utilization. It has achieved lower specific energy consumption per tonne of paper over the years. The unit has both quality and environment policies, and these policies, are publicly displayed. The unit has ISO 9002 and is in process of implementing ISO 14001 certification which is likely to be achieved by the end of year 2002. The plant has received the Energy Conservation Awards, administered by Energy Management Center, Ministry of Power, Government of India, many times. Although, the unit does not have a formal energy management policy as yet, the energy management and energy conservation is the critical focus of the management. The unit is in the process of formulating its energy management policy. Plant management believes that having a corporate policy gives clarity and systematic approach throughout the organization to meet the desired objectives. Process flow sheet for Ballarpur Industries Ltd is given in Annexure 7.4.

Achievements of the unit on the energy front are discussed in detail in the annual report of the company. The annual reports mention about large energy conservation projects undertaken by the unit in the previous year. For formulating energy management policies at corporate level, a discussion based on cross-functional approach is being adopted, and all levels of management are involved in the brainstorming exercise that will lead to the development of corporate energy management policy.

7.4.1.1 Energy conservation cell and its activities

The plant has formal energy management cell headed by a full time Energy Manager. Members in this department are drawn from various departments. There is multi-disciplinary team of engineers working in this department. The cell is also supported by General Managers and Managers of process and engineering departments. Advantage of having cross-functional and inter-disciplinary team is that perspectives of all the areas are discussed for identifying and developing energy conservation projects.

As part of its responsibilities, this department coordinates with other departments to identify new energy conservation projects. It also collects information on energy management projects that have been identified by other departments. For project execution and implementation, the department coordinates with engineering section and the concerned department where the project is to be executed. After execution of the projects, energy cell also monitors the outcome of the projects. Daily energy consumption reports are prepared and circulated to all levels of management. Follows up meetings are held with top management to discuss key performance indicators and other key issues regarding the operation of the plant. Energy related issues are also reviewed and discussed in these meetings. Detailed reporting of energy, environment, quality and safety is done in there meetings. Performance improvement areas under each section/department are also discussed in these meetings. Top management also reviews the progress of various schemes that are under implementation/consideration in different departments.

Energy conservation cell of the plant also conduct in-house training programs for the plant personnel to appraise them on energy conservation issues. External faculty is also called for this purpose.

7.4.1.2 Initiatives to promote energy management

As part of innovative management, the plant organizes small group activities, although not focusing exclusively on the energy aspects. These activities are organised at various levels, from shop floor to top management level and the frequency is once in a week for all levels. To assess the potential for energy conservation, the plant conducts energy audits which are conducted internally as well as externally. However, the energy audits by external firms are conducted once in two years.

Plant has an internal system of setting targets for energy consumption. These targets are decided on the basis of (1) last year's energy consumption, (2) best energy consumption figures in the paper sector. While setting the targets, emphasis is also given to best international norms for pulp & paper plants.

To promote employee motivation/education, the plant has a suggestion and slogan scheme on energy conservation. Plant personnel are trained in energy efficiency/management through both in-house and external training programs. Energy efficiency achievements are also discussed in internal newsletters. Training on energy conservation/management is carried out on as per requirement basis. There is no separate training budget and money, for this activity, is withdrawn from energy budget whenever needed.

7.4.1.3 Investment in energy management projects

The plant has a separate budget for energy conservation at the start of a year. The top management approves yearly plans in advance. For making investments in energy management projects, thorough tehno-economic analysis is carried out, which weighs the quantum of energy savings with the extent of investment required. However, preference is given to those projects that can be executed in-house by the plant. Small investments don't need the approval of the top bosses however the large investment needs the clearance from the top. Plant has undertaken several large revamp/retrofit projects in the past that have helped to improve productivity and bring down the energy consumption levels also.

7.4.1.4 Government policies

The management feels that present government policies are not conducive to promote energy management in industry. More legislative support is needed from the government to promote energy conservation in the industry.

Plant also insists on excise duty relief for purchase of capital equipment, subsidies for the promotion of use of energy efficient equipment, R&D support for selected projects, etc by the government. Government should start continuous awareness campaigns on issues related to energy conservation and it may be initiated right from the school level.

The State, in which the company is located, does not have any legislation for mandatory energy audits. However, it is felt that mandatory energy audits would not go a long way in promoting energy management. Plant feels that the urge should come from within.

7.4.1.5 Barriers to implementation of energy conservation measures

As per the plant, the main barrier to implementation of energy conservation measures is high cost of technologies and non-availability of improved/better equipments indigenously. High rate of interest and lack of funds are the other factors inhibiting the pace of energy conservation.

7.4.1.6 Major issues for effective energy management policy

The first and foremost thing in an energy management policy is the commitment of the top management. This will ensure that the plant implements the guidelines adopted in the policy and top management will have strong commitment throughout for promoting energy conservation.

Next most important thing from the viewpoint of energy management policies is to regularly conduct energy audits to identify energy conservation opportunities and to install energy efficient equipment. With regard to implementation of energy management projects, industry must look forward to development of indigenous capability to implement energy management projects.
R&D projects (may be a joint research) must be undertaken to develop energy management solution in the plant. Maintaining a constant interaction with technology suppliers can further augment this effort.

For paper industry having high percentage of energy cost as total cost of production, it is mandatory to carry out energy monitoring and targeting. Setting up an energy cell headed by a full time energy manager will give further impetus to energy conservation efforts.

Since large paper plants are continuous process plants and breakdown in plant and equipment can prove very expensive. Regular preventive and predictive maintenance may be adopted in order to avoid such happening.

To motivate the staff to actively participate in energy management plants must have an incentive scheme to reward employees.

7.4.2 Star Paper Mills Limited, Saharanpur

Star Paper Mills Ltd., Saharanpur is one of the large paper-producing mills in India. The present capacity of the mill is about 150 tons per day. Star Paper is producing writing and printing, craft grade paper and board. The turnover of the plant for the year 2000-01 is rupees 1766 million. Energy cost accounts for 24% of the manufacturing cost or 16% of turnover. Plant has produced about 60,000 MT of paper and paperboard for the year 2000-01. The main raw materials used are hard wood and bamboo.

The plant was commissioned in 1937 and has continuously upgraded its facilities to improve the plant performance. The plant consumes coal, furnace oil, and black liquor (generated inhouse) as the source of energy for generating steam and power. Other than this, it also purchases electricity from the utility company.

The capacity utilisation of the plant, for the last three years is well above 100%. The plant is continuously upgrading its energy performance, by implementing a number of technical measures in past several years, which is evident from the downward trend in its specific energy consumption pattern. Plant has implemented a numbers of low and medium cost energy saving measures in the past, which have resulted in good energy savings.

There is no environment and energy policy in place for the plant. However, the plant has quality policy, which is displayed publicly. Plant has received the ISO 9001 certification. Energy management is a critical focus of the top management and they participate on a regular basis in planning and review of various energy management projects. The annual reports of the company briefly discuss the details about energy management policy and projects. With regard to formulation of energy policy and energy plans, a participatory cross-functional approach is taken, where feedback is taken from personnel (different levels of managements) from different departments.

7.4.2.1 Energy conservation cell and its activities

The plant has a separate energy management cell, which is multidisciplinary in nature. The members of this cell are drawn from various departments of the plant. The posting in the cell is on rotation basis, to increase the awareness and commitment of the plant personnel, and to improve cross-functional integration. The average tenure in the cell is 2-3 years.

As part of its responsibilities, this department coordinates with other departments to identify new energy conservation projects. It also collects information on energy management projects that have been identified by other departments. For project execution and implementation, the department coordinates with engineering section and the concerned department where the project is to be executed. After execution of the projects, energy cell also monitors the outcome of the projects.

Energy consumption report is prepared daily and circulated to the section head on daily basis. Plant head and top management are appraised on energy consumption on weekly and monthly basis respectively. Follow-up meetings are held frequently with top management to discuss key performance indicators and other key issues regarding the operation of the plant. Energy related issues and the areas which need improvement, are also reviewed and discussed in these meetings.

7.4.2.2 Initiatives to promote energy management

Though, plant does not organizes small group activities, it has the schemes to motivate its employee for energy management. It is promoted through slogan and suggestion scheme. There is no in-house training programme on energy conservation for the employees on regular basis and there is no training budget for this also. Training programmes are organised whenever need is felt. Some times people are also sent to attend the external workshop/training programmes.

Internal and external energy audits are conducted in the plant to identify the energy wastage. The frequency of external energy audit is once in two years. As a driver for energy management, plant sets energy conservation targets and budget that are based on consumption norms. These targets are based on last year's energy consumption figures.

The plant shares its achievements in energy conservation with other plants in the country. Information is also shared by paper mill associations. But it is felt that there should be more frequent interaction among the plants and associations. Associations should organise seminars, industry meets, etc on the topics related to energy management. Plant personnel also feel that associations should maintain the international data on energy consumption in pulp & paper industry and prepare energy consumption benchmarks for Indian counterparts.

7.4.2.3 Investment in energy management projects

During annual budgeting exercise, no separate budget is kept for energy conservation. Top management takes mostly decisions on energy investments. Investments in energy management projects are made on the basis of sound techno-economic analysis and quantum of energy saved is an important criterion in decision making. Emphasis is given to those energy management projects that can be executed in house and for large energy management projects approval is needed from top management.

7.4.2.4 Government policies

During the discussions it was brought out that the present government policies are not conducive to promote energy efficiency in the industry. Government support in the form of equipment subsidy and demonstration plants is needed to promote energy efficient technology in the industry.

Plant has the view that there is shortage of wood based raw material and it is likely to be acute in the future if the policies are not modified. Presently, lot of wasteland is available which remains unutilised. If paper mills were allowed to grow trees as per their raw material requirement, it would be of great help to them. Plant also feels that since there is no security of raw material in future, paper industry is apprehensive in increasing the plant capacity. Lower size of paper mills is one of the causes for higher energy consumption.

Government must also give custom and excise duty relief for purchase of capital equipment. Subsidy must be given by the government to promote the use of energy efficient equipment. R&D support for selected projects must be provided by the government. Industry can carry out collaborative research to promote energy conservation. Similarly, there should be continuous awareness campaigns on issues related to energy conservation and it should start right from the school level.

Mandatory energy audits are not enforced in the state. For any energy audit to be effective, there must be an initiative at plant level, and mandatory energy audits may lead to dilution of the purpose.

7.4.2.5 Barriers to implementation of energy conservation measures

The plant feels that high cost of technology/energy efficient equipment is the main barrier to implementation of energy conservation options at plant level. Also, inadequate government policies to promote energy management in the industry hinder the pace. Other barriers are the lack of awareness on the issues related to energy conservation and availability of funds.

7.4.2.6 Major issues for effective energy management policy

The foremost thing to promote energy conservation is top management's commitment towards energy conservation. Strong commitment from top will ensure that energy management projects will get adequate support from top management. Similarly, the motivation at lower levels to conserve energy will be high.

Role of conducting regular energy audit is also very important in order to identify opportunities for energy conservation. Help of external agencies in this regard not only generate new areas but also improve the inhouse capabilities. Installation of energy efficient equipments further consolidates the plant's endeavour to achieve energy efficiency in the mill.

As part of energy conservation strategy, plant must adopt monitoring and targeting scheme to reduce energy consumption. The targets can be set based on a mutual consultative manner and all efforts should be made to achieve those targets.

7.5 Issues to be stressed while framing the energy policies of the paper industry

7.5.1 Top Management Commitment

It is very important for the shop-floor worker to see the commitment of the top-management towards energy conservation. Demonstration of the top management's participation and encouragement are hence very important to the shop-floor worker and the CEO should make this visible to them. It sends right message for the employees at the lower end. This will ensure employee participation, which is probably the most important tool for Energy management.

Top management's commitment could be in the form of company's energy policy, regular interaction with lower end people on the matters related to energy conservation, etc. will also help in generating commitment from the lower management.

7.5.2 EMC headed by a full time manager

To make EMC more effective, it would be very useful to appoint a full time manager who will concentrate only on every aspect of energy conservation. Giving additional charge to a person who is already involved in some other activity will not leave much time for him to spend on these activities.

7.5.3 Energy management information system (EMIS)

Reporting of energy consumption is a very important activity. It helps in understanding the consumption pattern over a longer period as well as with the variation in any input. It also helps in understanding the reasons such change in raw material mix or seasonal variation or break down, etc. behind the change in consumption pattern.

In order to ensure quick grasping of variation in energy related data and it's speedy correction, instrumentation and control is an effective measure. An online computer controlled system could be of much use in this. The system that would run over the whole plant through a network of instrumentation & control and sends data to a computer centrally. The central system should be able to analyze the data in a useful manner and control/suggest intervention depending on its criticality while taking into account the process parameters and safety aspects. A monitoring system should be developed and data may be grouped in daily, weekly and monthly category as per their criticality.

There should be regular meetings of energy management cell with the concerned departments, where a notable deviation is observed in the consumption pattern, to discuss these issues and to suggest the corrective actions. There should also be the regular interaction between the EMC and higher management to appraise them and to have their views/feed back on current activities and to further strengthen it. This activity will also help in preparing the energy budget for subsequent years.

7.5.4 Monitoring

Many studies and reports have identified poor quality of monitoring and record keeping as the key lacunae in energy management practices at the unit level. Monitoring is, in fact, needed to keep the performance tracking of various energy consuming equipments used in industry which could be used for efficiency comparisons at later stages. In general, there is a tendency in the plants to view monitoring and record keeping as a formality and the commitment to genuine monitoring is low. This could be because of poorly trained staff or inadequate resources or due to both. The management should understand that continuous monitoring would give the better insight of the day-to-day operations and help in efficient management of the same.

7.5.5 Internal energy award system

Starting an internal award system would be a good motivating agent among the various departments in a paper mill. This should be yearly basis. The department achieving the maximum specific energy reduction (because efficient performance, implementation of the scheme suggested by department, due to long uninterrupted running of machines, etc) for the past year may be given this award for one year. Any department getting this award for three successive years may be given some monetary benefit (from the monetary savings thus achieved) as a token of appreciation. This will encourage the individual in each department not only to perform efficiently but also to maintain this performance.

7.5.6 Target setting

It is important to set long-term goals and based on this, year-wise targets may be framed. In the absence of comprehensive energy policy in paper industry, in general, short-term targets of the duration of one year or less are set as evident from the questionnaires. Every plant should create own target as it is unique and its technology, vintage, consumption patterns, location, products, etc are different as compared to others. Comparison with other plants in the sector to know one's standing is ok but setting target considering the consumption figures of other plants or best in sector or international may be misleading. While in the immediate future it may not be possible for the best Indian companies to achieve the world average figures for energy consumption but a carefully planned out roadmap leading to this ultimate objective should be able to guide the plants to a better energy efficiency.

A detailed evaluation system of the energy conservation/management plans should be worked out in order to comprehensively analyze the benefits and costs to the company. The benefits should be calculated in terms of energy savings, savings in energy costs in its long-term use and viability of the project. Evaluation should also take into account the 'invisibles' such as safety, improved environment, improved quality and reduced maintenance.

7.5.7 Energy audit

Energy audits can further firm up the efforts of EMC regarding the energy conservation. It can be carried out internally and externally. Frequent energy audit will identify the grey areas and energy wastage can be thus identified and process optimised. To further consolidate the plant's endeavour, external energy audit should be carried out regularly. External audit will provide new tools/methods for energy conservation and will strengthen the capabilities of the internal auditing team. It will also identify new areas and evolve suggestions for further improvement.

The outcome of the audit should be implemented in phases depending on the requirement of investment. Housekeeping, no or low cost, measures may be implemented immediately whereas the high cost measures may be implemented later in phases. Implementation of housekeeping and low cost measures will reduce energy consumption gradually whereas the implementation of capital intensive measure will reduce the energy consumption substantially. Continuous monitoring of these implemented measures is required to evaluate whether these are performing well and resulting in to the desired energy savings or if they need some modification according to the local conditions.

Moreover, Energy audit is going to be mandatory all over India in near future. The bill, in this regard, is already passed and rules and regulations are being framed. The industry, however, feels that mandatory audit may not help; only plant management's commitment to conserve energy and reduce their costs will help.

7.5.8 Capability enhancement/ Motivation

In order to reap the continual benefit due to energy conservation, it is important that there should be regular augmentation in the capability of the persons engaged in energy conservation related activities and directly in production. These personnel could be from energy cell or from the different departments. Some paper mills already have a system to educate the people who are directly involved in production. It is, normally, done by in-house energy management cell. As per the recent reports, large inefficiencies in the industry indicate that there is a lot of potential that is still not realized. This can be achieved by way of having a proper structured energy management cell and enhancing the effectiveness of its interaction with the manufacturing divisions of the company.

Normally, the technical skill of the people working at shop floor level is very poor. In fact, these are the people who operate the machines and are directly involved in process, and can play a major role in reducing the energy consumption in a plant. Therefore, training of these people on energy conservation aspects is of great importance. The shop floor people normally don't go for internal/external training, and the knowledge gained by higher management people through various interactions like meetings, workshops, seminars, etc are not shared with shop floor level people or operators. Therefore, their awareness level on the issues related to energy efficiency remains very poor.

Thus, the energy management policy should effect energy conservation/ management through training and systematic education about the equipment/s they handle, to workers. In this context it would be very important that the content of the training be tailored to suit the education level of the workers.

Constitution of a small inspection group or 'Patrols', as is the normal Japanese term, is a useful tool to enforce energy management. Patrols are normally undertaken by senior managers who go around the plant and meet the workers and talk to them about the energy issues and plants' performance while asking them of their duties and their efforts for Energy conservation and performance improvement of the equipment. Patrol is very common in Japanese industries and top manager or the heads of the works undertake it occasionally.

7.5.9 Interaction with technology suppliers and government agencies

The plant should continuously interact with technology suppliers and keep itself abreast with the latest energy efficient technologies and the energy conservation gadgets available in the market. Also, they should keep an eye on the government's policies and available incentives on energy conservation. Currently, there are number of incentives offered by Government such as full depreciation in the first year on energy saving equipments, rebate on the various duties, assistance offered by government agencies (PCRA, IREDA), soft loan offered by national development banks, etc. Paper mills are generally not having information on these schemes. This may be due to poor advertising from government's side also.

7.5.10 Energy efficient equipments

It is very common in India that while setting up a new plant, it is tried to keep capital cost as low as possible and, therefore, technology/equipments having low first costs (less efficient) are preferred. A low first cost technology may, finally, result in to higher operating cost compared to the more efficient technology/ equipment having the higher first and lower operating cost. This may result in to higher life cycle cost for low first cost equipment/technology. A more efficient technology/equipment with higher first cost but lower life cycle cost must be preferred. With the past experience, it has been established that once the investment is made in inferior technology, it is expensive to retrofit than to opt for a more efficient technology in the first section.

In most cases in the past, emphasis has been given more on adhoc energy conservation measures rather than on structural change or promotion of new and efficient technology because of ease and low cost of the former. Change of the technology leads to a steep improvement in energy performance whereas individual energy saving measure will lead to small improvements.

7.5.11 Need of the energy policy

The industry is doing energy conservation but it lacks commitment. The commitment may come and be shown in the form of industry's energy policies. Like quality and environment policy displayed publicly, energy policy should also be framed and be displayed publicly. This will bring the commitment for energy saving which, in general, is voluntary only. Energy policy at plant level and corporate level also shows the commitment of top management and leaders which will also help in transforming the policy framing from the ad-hoc to long term well structured one. These policies may be communicated in organisation by assigning the responsibilities to the departments and also decentralising the decision-making. Regular meetings should be organised including the top management to discuss and review the progress of energy conservation activities in the plant.

It is desirable, for framing the energy policy, to involve as many as possible persons from various department e.g. production, maintenance, quality, instrumentation, etc at various levels (managers, engineers, supervisors, etc.) in process of formulation (cross functional bottom-up approach). The work accomplished this way will have maximum acceptability as maximum numbers of persons are involved and they will own the policy. The same exercise, if carried out by few managers in a centralised manner or the policy decided by corporate office will have less acceptance as it may be felt that these are imposed from the top without having their participation for an assignment to be carried out by them regularly.

7.5.12 Separate energy budget

In order to implement energy saving technologies, rational budgeting support is a must. This should be made possible under the guiding policies of the company on investment and should be evaluated thoroughly on its energy-conservation and economic aspects.

There should be the separate budget allocated for energy conservation every year which ensures smooth execution of such activities. It would be useful to carry out the feasibility study or techno-economic analysis before making the investment in an energy project. Return on investment (energy savings) is one of the important investment criteria in decision-making. Decision-making on investment should not be centralised to one person. Top management can sanction large investment but the decision on small investment can be taken by lower/ middle management. The value of small and large investment may be decided by the company itself which may be different for different companies. It is preferable to implement the suggestion having no or low cost and emerged out due to the internal exercise but it is also not advisable to avoid large projects for a long.

7.5.13 Small group activity

Energy management and conservation activities should be taken up at all levels starting from the lowest as it can only be achieved by joint efforts of all plant personnel. Thus small group activities, project team activities and technology development all form important parts of the energy saving promotion.

Small group activities that are organized among the shop floor level people such as operators and foremen to educate them about the contribution they can make and its importance to make the plant more energy efficient. In India, taking into account the current level of education among the workers and the vast possibilities of technological improvement at the given stage, this still has a great potential, as observed during the plant visits. Small group activities are picking on and are proving to be very valuable. The only investments are in the form of employee education and enhancing their motivation. This approach has been found to be very useful in the Japanese plants.

Group activities help in identification of improvement ideas. Selected suggestions from this forum may be sent to EMC for further scrutiny. Feedback from this group activity will help the EMC in monitoring the suggestions implemented, identifying the shortcomings and further improving it, etc. Small savings at many points in the plant, due to this activity, can add to a sizeable amount.

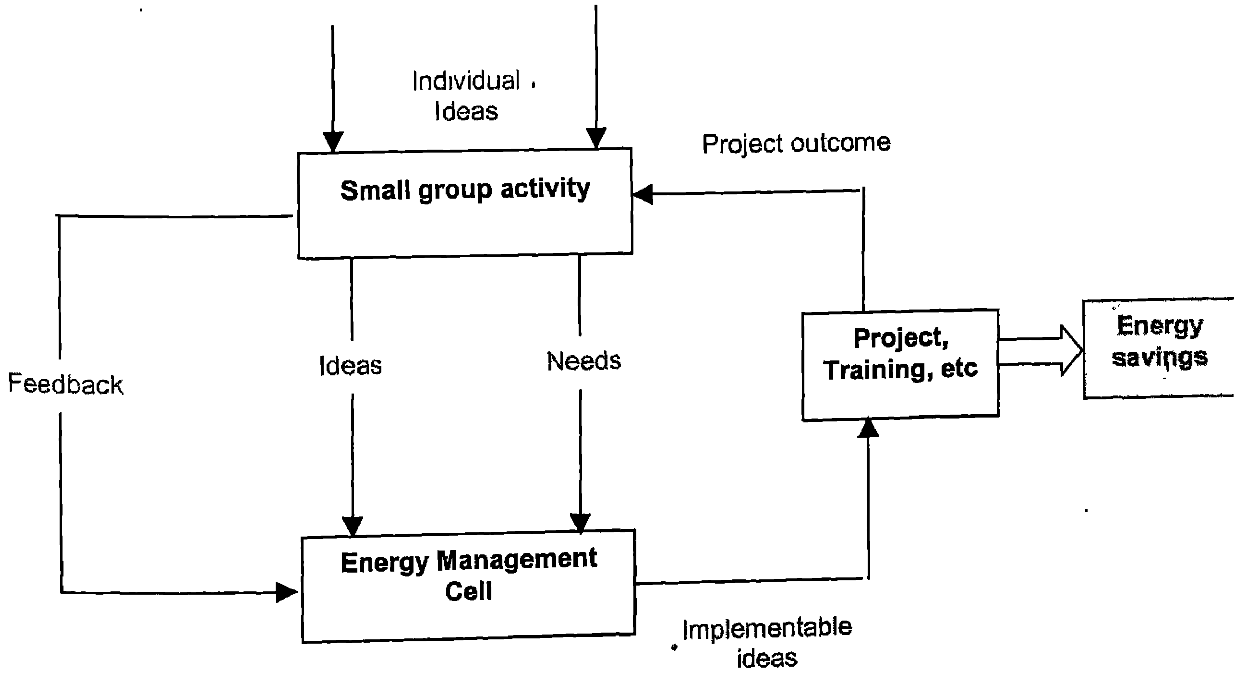


Figure 7.5.13 Small group activity for energy savings

A culture of energy consciousness is very important to build the edifice of better energy efficiency. Small daily activities like putting off lights when leaving workplace and other such small things would not only save energy but also reinforce the culture of energy conservation. Employee education and motivation are in this regard, important inputs.

7.5.14 Information sharing and role of industry association

This process, however, should not stop here. The case study can be shared with other plants of the sector or associations by getting it published. The plants should also share other information related to production and consumptions, etc with associations so that can maintain/publish the statistics about the sector. The association should also keep the track of international players and should have the information about their energy consumption, technologies, market conditions, etc. This information should be made available to all the members. The association should also organise industrial meets, seminars and buyers-sellers meets on energy conservation. Based on the information collected, association should frame the norms for various types of products and also revise it from time to time.

7.5.15 In-house research and development

In-house development of energy saving technology or adaptation of a technology to suit plant conditions is also important part of generating energy savings. In general, paper mills spend very little amount in in-house research and development activities. Such activities need to be taken up at a larger scale.

In order to develop in-house technologies for energy conservation, regular interaction between the EM cell, manufacturing shops and the R&D division should take place. In-house design and development has the benefit of being tailor-made for the plants' specific conditions while being available at a lower cost. The energy management policy should lay down the path for a process through which the design & development is effective. This should evolve around the needs of the plant as enunciated by the manufacturing shop/EM cell, and it's solution provided by the R&D team. The EM cell should constantly be on the lookout for technologies and practices which will ensure energy conservation and be ready to adopt these to suit the needs of the plants in accordance with the above guidelines.

Summary of the data collected from plants

Annexure 7.1

Plant no.	Specific energy consumption (per MT of paper)						Future targets (per MT of paper)						Turnover (Rs. Lakh)	Energy share of manufacturing cost (%)
	Electricity (KWH)			Steam (MT)			Electrical (KWH)			Steam (MT)				
	98-99	99-00	00-01	98-99	99-00	00-01	00-02	02-05	05-10	00-02	02-05	05-10	00-01	00-01
1	1281	1295	1286	8.5	8.5	9.1	1260	1250	1200	8.6	8.4	8.0	39819.6	19.2
2	1288	1252	1239	8.9	8.5	8.4	1210	1170	1100	8.2	8.0	7.7	48738.0	26.5
3	1092	1035	1025	13.2	12.8	12.7	1015	1000	975	12.5	12.0	11.2	55614.0	43.1
4	1093	985.5	969	3.1	3.3	3.2	by 8 kWh	by 10 kWh	-			-	15441.0	22.0
5	1914	1829	1826	21.0	19.6	19.2	1750	1700	-	18.0	17.5	-	23700.0	21.0
6	1391	1336	1321	10.5	9.9	9.6	1305		-	9.3		-	17661.0	24.3
7	759	481	613	-	-	-	by 50 kWh	by 80 kWh	by120 kWh	by 0.5T	by 0.6T	by 0.65 T	1785.0	30.1
8	1615	1628	1674	9.3	9.7	10.2	1750	-	-	9.7	-		28555.1	13.6
9	1308	1212	1199	7.8	7.6	7.3	-	-	-	-		-	8235.9	26.0
10	1007	1155	-	2.3	2.2	-	800	700	-	2.1	2.0	-	-	-
11	1678	1630	1639	7.3	7.2	7.0	-	-	-		-	-	59519.6	27.9
12	1760	1829	1740	11.7	12.5	9.7	by 26 kWh	by 25 kWh	by 25 kWh	by 0.2 T	by 0.2 T	by 0.2 T	26214.0	30.0
13	1740	1526	1507	-	1.0	9.8	-	-	-		-	-	45747.9	17.0
14	1924	1735	1805	9.5	9.1	12.0	1700	1600	1500	11.0	10.0	9.0	24082.0	19.0
15	1443	1356	1281	6.8	5.6	5.9	1150	1100	1025	5.5	5.2	5.2	-	-
16	1833	1710	1536	12.5	12.2	11.6	1500	-	-	11.0		-	26675.6	22.0
17	2072	2080	2072	1.4	1.3	4.7	by 5%	by 5%	by 5%	by 5%	by 5%	by 5%	25335.6	35.0
18	1763	1562	1550	13.6	13.1	13.6	1525	-	-	13.3	-	-	11452.6	30.9
19	1962	1734	1673	25.5	22.2	21.8		-	-	-	-		5992.6	33.7
20	1126	1034	1030	12.9	12.3	12.6	1000	950	900	12.0	11.8	11.5	24198.5	10.5
21	1793	1798	1855	14.1	14.6	15.1	1800	1750	1700	14.0	13.5	13.0	17929.0	21.9
22	1171	1254	1251	6.3	5.6	6.4	1200	1150	1100	6.25	6.1	6	2899.9	27.1

- Not given

Production data

Plant no.	Commissioning year	Installed capacity per annum	Products	[illegible]			Capacity utilisation (%)		
				98-99	99-00	00-01	98-99	99-00	00-01
[illegible]	1958	119750	Writing & printing, kraft, Duplex board, MICR cheque paper	116644	112521	120210	97	94	100
[illegible]	1936	53868	Writing & printing	66591	70017	70273	124	130	130
3	1953	89500	Writing & printing	104079	113004	114363	116	126	128
[illegible]	1991	35000	Kraft	29103	41998	44092	110	120	126
5	1965	85000	Writing & printing, kraft, board, tissue, poster	61332	69593	72802	72	82	86
6	1937	46200	Writing & printing, craft, board	53269	58457	60039	115	127	130
[illegible]	1991	19800	Craft, Board	13812	13572	13128	53	52	51
8	-	98500	Writing & printing, craft, board	91543	94334	88745	93	96	90
9	1982	33000	Writing & printing	25899	28623	29356	106	95	98
10	1990	22000	Craft, board, newsprint, poster, tissue	15623	17455	-	71	79	-
11	1984	180000	Writing & printing, newsprint	176075	178871	191106	98	99	106
12	1962	115000	Writing & printing, craft, pulp board, coated papers, LWC	59083	60042	82240	98	100	76
13	1984	153170	Writing & printing, Rayon/paper grade pulp, bagassed paper	95296	147932	145155	434	674	661
14	1986	100000	Writing & printing, copier, duplicating SS Maplitho	60009	65823	76722	60	66	77
15	1980	26400	Writing & printing, newsprint	21951	28168	30418	83	107	115
16	1985	100000	Writing & printing, newsprint	90174	98783	100841	90	99	101
17	-	100000	Newsprint	105570	91004	104004	106	91	104
18	1994	36000	Writing & printing, sheet pulp	22185	34970	34412	68	97	96
19	-	22000	Writing & priting, craft, board	12917	17635	20682	78	80	94
20	1979	98550	Wood pulp (Rayon Grade)	61777	85501	92266	63	87	94
21	1938	61550	Writing & printing, Kraft, Board, speciality papers like MICR cheque paper	57334	58839	60197	81	96	98
22	1982	15500	Writing & printing	10341	8425	9525	67	54	61

Energy Consumption

Plant no.	Fuel Consumption												Electricity Consumption								
	Coal (MT)			Furnaco oil (KL)			Diesel (KL)			Black liquor (KL)			Purchased (MWH)			DG sets(MWH)			Steam turbines(MWH)		
	98-99	99-00	00-01	98-99	99-00	00-01	98-99	99-00	00-01	98-99	99-00	00-01	98-99	99-00	00-01	98-99	99-00	00-01	98-99	99-00	00-01
1	115402	108508	117423	7624.07	14148.22	19.539	11584	8050.5	1232	586910	569450	637570	181.67	109.62	153	735.1	871.08	852	576.69	475.96	542
2	50164	50972	48203	288.7	255 7	295.5	-	-	-	84772	93132	95973	2757	2666	5888	-	-	-	83035	85659	81197
3	70684	80086	76718	-	-	-	-	-	-	184351	186476	188719	18059.45	9083.389	8606 04	-	-	-	198671.6	209189.8	206042
4	18577	24216.8	24339	-	-	-	-	-	-	-	-	-	318.17	413.9	427.18	-	-	-	-	-	-
5	173376	183832	192505	430.5	398.5	519.9	-	-	-	862350	971400	960485	3496	1322	2856	-	-	-	113729.8	124835.2	128456.8
6	27206	22870	20232	4164.32	4059.87	1995.48	-	-	-	84675	96336	96818	47.27	13.49	6 68	0.574	39.76	46.92	26.96	25.53	25.93
7	5632.165	4063.85	3580.82	-	-	1714000	2720270	2407515	596000	-	-	-	3285.325	-	-	7200	6525	8050	-	-	-
8	187119	204554	196142	678.535	815.5	1002	1115.91	336	105.29	-	-	-	357.15	358.95	407.12	38.76	10.66	5.16	1197.3	1292.1	1191.76
9	-	-	-	-	-	-	100680	135575	140695	18301	21392	24372	23379.42	23884.6	24183	316.82	431.356	446.627	10176.92	10389.16	10566.86
10	-	-	-	217740	-	-	-	-	-	-	-	-	2634090	-	-	13100.44	20160.53	-	-	-	-
11	349692	326554	309922	7934	8105	8957	-	-	-	140711	158372	157205	70646	45071	46539	-	-	-	207847	217924	244316
12	23014	47168	47549	1234	819	815	40287	12952	23513	90928	86338	107097	59554	70018	95516	-	-	-	44402	39820	47587
13	138047	194728	207967	7939	11106	10809	582592	490567	711699	-	-	-	13342	15142	17412	1976	1617	2229	139611	196821	189300
14	106117	96923	114757	892	583	528.5	-	-	-	101646	108291	136154	18246	13494	12172	-	-	-	122300	132751	165668
15	-	-	-	-	-	-	80.925	136.836	8.36	-	-	-	31358	37754	38577	307	455	28	-	-	-
16	147621	171497	165916	855	672	986	-	-	-	123071	135480	144584	17592.08	14464.92	27421.75	-	-	-	200036.4	212302 8	180395.4
17	94952	76529	86695	4047	3715	4063	-	-	-	46755	36892	44289	134700	115500	141000	1100	100	13.9	63000	73700	74500
18	61384	86485	113124	734	848	383	-	-	-	40658	41115	39799	20148.64	21070.41	9737	-	-	-	-	-	-
19	69985	87707	102867.31	396 59	220 8	233.9	-	-	-	-	-	-	8605.2	11023.78	11689.1	-	-	-	16740.2	19524.31	22918.68
20	69200.92	91855.46	96258.6	2595.38	2008.99	2123.22	-	-	-	132652	163109	189199	8049	8286	10957	-	-	-	68783	80174	84099
21	229197	244181	249292	149	124	135	-	-	-	81880	88400	92006	2375	1950	2018	-	-	-	110605	115818	122617
22	14414	10561.88	13541.33	-	-	-	-	-	-	-	-	-	121.1	105.66	119.17	-	-	-	-	-	-

Annexure 7.2

Energy saving measures implemented in the paper industry

Electrical	Interlocking of paper m/c vacuum pumps with respective fan pumps Isolation of process & inst. Air Installation of timer for pulper to reduce idle running Installation of variable speed drive for FBC boilers ID fan Installation of energy efficient tower agitators Installation of energy efficient floating type surface aerator Reduction of oversized pump capacities by trimming the impellers in pulp mill centri cleaner pumps Replacement of aluminium fan blades with FRP fan in select motors applications Replacement of machine chest pump of paper machine by a higher capacity energy efficient pump
Thermal	Modification of venting steam utilisation for DM water heating Installation of dump condenser in steam cycle for utilisation of waste steam Installation of two stage air preheating in SR boilers Modification of steam and condensate in paper machine including additional thermo compressor in the select group of dryers, eliminating venting Installation of automatic blow down systems
Process improvement	Implementation of smoothening press conversion with inverted felt press to improve dryness of paper web entering dryers Modification of pulper at the paper machine to reduce idle running of batch pulpers Optimisation of refining process for paper manufacturing Implementation of heat exchanger for digester flash vapour Modification of paper machine press suction tubes Modification of paper machine pre-dryer Utilisation of decker back water in fibre fractionator Utilisation of paper machine back water in the under pulper of the same machine Optimisation of paper machine refining power by changing over from conventional to conical refiners Replacing mill water in paper machine showers by clarified m/c back water Replacing existing recovery evaporators with falling film evaporators Use of forced circulation (FC) evaporator flash vapours in multiple effect evaporator plant after thermo compression Replacement of medium pressure (MP) steam ejectors with low pressure (LP) steam ejectors Installation of variable frequency drive in pulp mill washer Modification for reuse of foul condensate of new evaporator in bagasse pulp mill Installation of trim shredder/pulper in paper machine Bypassing final chest pump and agitator by providing additional valves in the pulp lines Modification to run bottom press of PM-II without inner fabric felt

Installation of falling film finisher for black liquor evaporation
Replacement of venturi scrubber and separator with cascade ESP in B&W recovery boiler
Modification of recycling paper machine effluent in vacuum pumps (MF & MG)
Recycling paper machine effluent for wire showers
Utilisation of paper machine effluent in pulp mill tower dilution
Installation of fish tail showers in place of drilled hole showers to save fresh water
Installation of additional drum chipper in place of inefficient ERH chipper
Installation of smoothening press conversion with inverted felt press to improve dryness of paper web entering dryers
Machine efficiency improvement due to automation in wet end and dry end controls
Modification of existing suction press with high nip load solid press to save power and improve paper dryness by 2%
Installation of higher capacity vacuum pump with suction separator to improve efficiency
Reduction in the cooking pressure of digesters
System modification in soda recovery to stop running of black liquor transfer pump
Auto combustion control in CF boilers

Energy Management Policy Statements and Organisation charts

Tamilnadu Newsprint and Papers Limited

Committed to meet the entire energy needs through in house generation with emphasis on-

- Maximum fuel usage through eco-friendly agro waste
- Export surplus electricity to grid
- Continuous process improvement of efficient generation and efficient usage of energy through various energy conservation measures
- Involvement of all employees towards cost reduction in generation of steam and electricity and efficient utilisation of energy

The West Coast Paper Mills Limited

Committed to achieve Total Energy Management (TEM) by adopting-

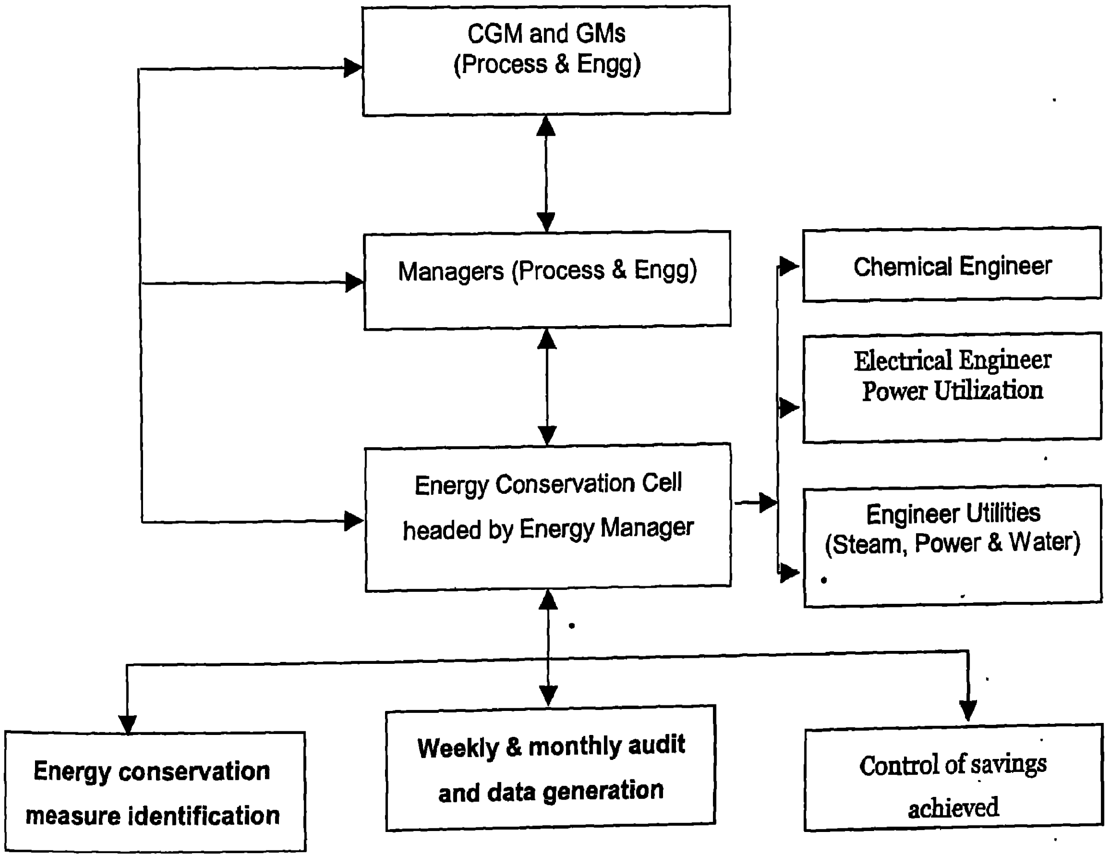
- Progressive reduction of specific energy consumption
- Induction of energy efficient equipment by continuous absorption of latest technology and process development for saving resources and environment
- Perpetual energy auditing for continuous improvement of process and optimisation of energy cost
- Involvement of employees to minimise energy wastage through small group activities

Amrit Paper

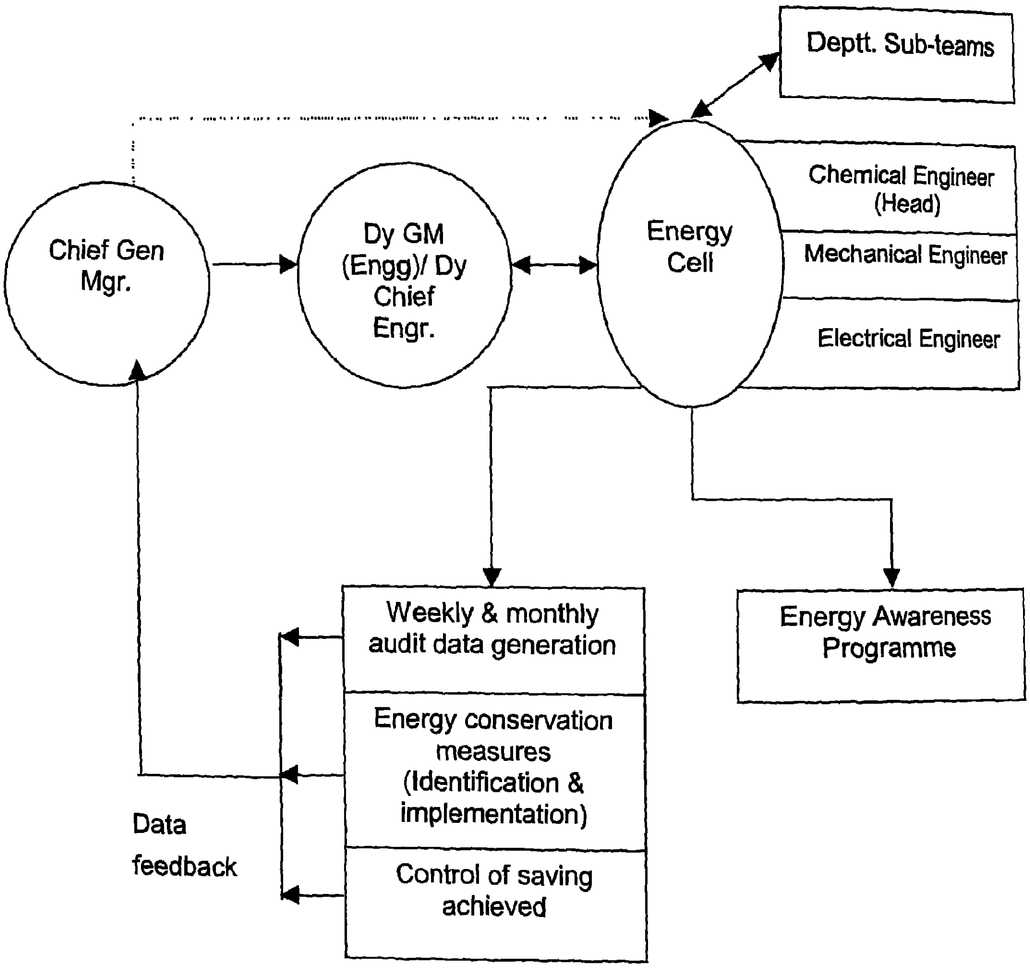
- To optimise plant operations using energy efficient equipments thereby achieving required level of limiting factors
- Using the best devices available to save the energy, applying all the preventive measures and reviewing the controlling parameters time to time
- Exploring the possibilities of power generation using eco-friendly renewable sources

Organisation charts

Set up of Energy Conservation Cell at BILT, Yamunanagar

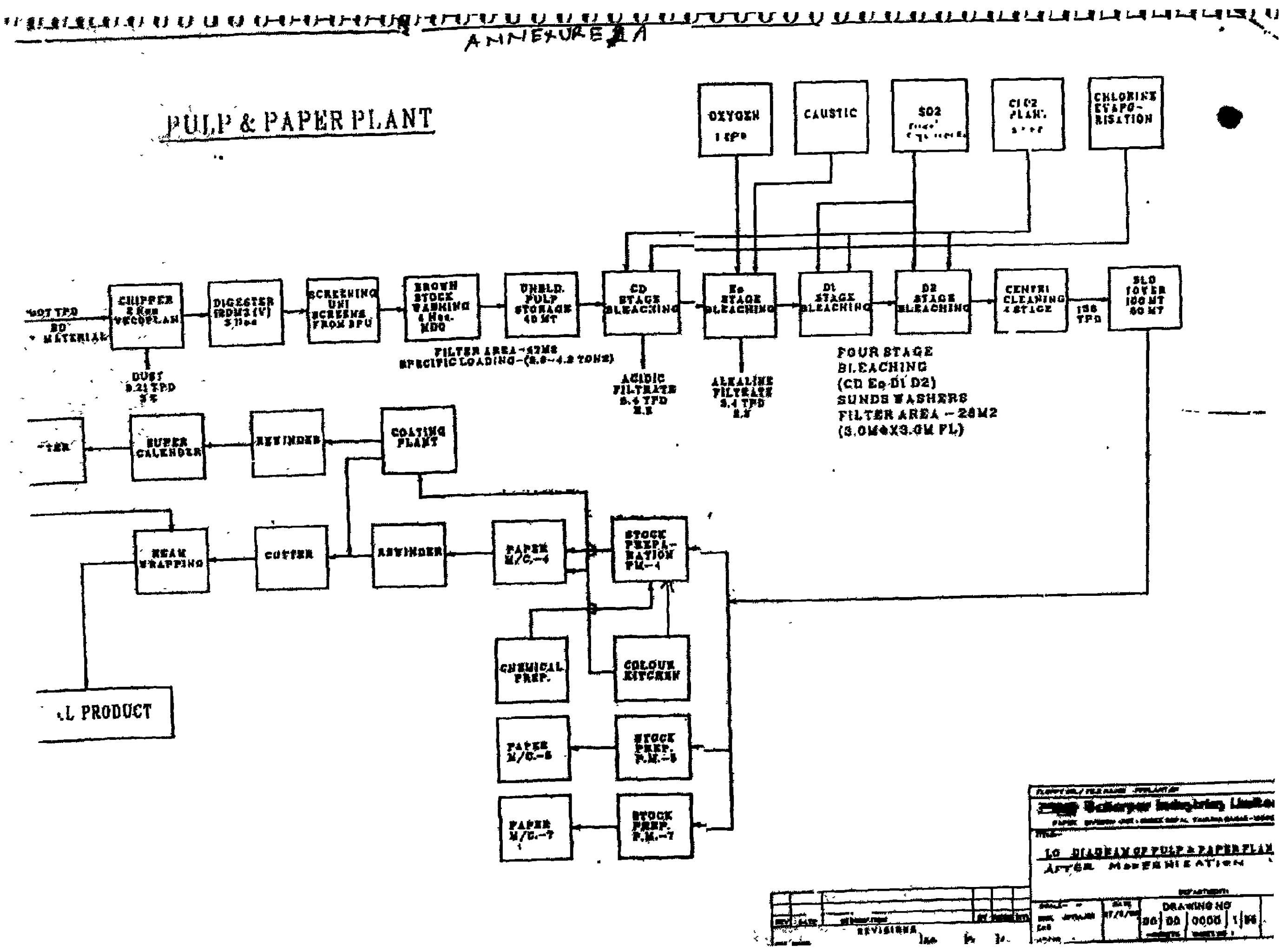


Set up of Energy Conservation Cell at BILT, Chandrapur


Deptt. Sub-teams
Chief Gen Mgr.
Dy GM (Engg)/ Dy Chief Engr.
Energy Cell
Chemical Engineer (Head)
Mechanical Engineer
Electrical Engineer
Weekly & monthly audit data generation
Energy conservation measures (Identification & implementation)
Control of saving achieved
Energy Awareness Programme
Data feedback

Annexure 7.4

Process flow sheet for Ballarpur Industries Ltd



8

Steel Industry

8.1 Profile of the Steel Industry

The Indian Integrated Steel Industry consists of nine major plants located mostly in the eastern areas rich in both iron ore deposits and coal. The location of the plants was conceived with the intention of having them close to raw material sources. In the days of supply driven market which was also hedged from external competition, the emphasis was mostly on production and not on cost cutting or energy efficiency. With the change in the business environment where market driven forces became stronger and in view of the integration of global environment concerns with the national concerns a marked shift towards incorporating energy efficiency and environment protection in the business activities has taken place. Initially the focus was on production technology and it was only recently in this process that energy efficiency concerns were seeded into the thinking of the respective managements. The plants have a wide range of facilities and this reflects in the energy consumption of the individual plants as well. An overview of the plants is given in Table 8.1a.

Table 8.1a Overview of the plants

	Unit	Process	Installed Capacity (mtcs)	Production (mtcs)	SEC (GJ/tcs)
1	TISCO	BF-BOF-CC	3.540	3 434	32.57
2	BSP-SAIL	BF-BOF/THF-IC/CC	3.925	3.743	29.49
3	BSL-SAIL	BF-BOF-CC	4.360	3.353	33.96
4	DSP-SAIL	BF-BOF-CC	1.802	1.500	31.39
5	RSP-SAIL	BF- BOF-CC	1.900	1.190	41.77
6	IISCO-SAIL	BF-OHF-IC	0.380	0.292	39.71
7	VSP-RINL	BF-BOF-CC	2.900	2.576	33.22
8	JSPL*	DRI-EAF	0.650	0.400	26.00
9	JVSL	COREX-BOF-CC	0.800**	0.670***	N.A.

Note: Data for year 1999-2000 N.A.: not available *sponge iron
**Second phase 0.80 mt capacity addition ongoing ***saleable steel

In order to develop the guidelines for energy management policy for the plants comprising the Integrated Steel Industry, it was decided to undertake a questionnaire survey that was followed up by plant visits. A total of nine (9) questionnaires were sent to the plants listed above. The response however was not forthcoming in most cases expect two plants which responded immediately.

Follow up with the others did not result in any results either. The plant visit to a third plant undertaken resulted in very useful discussions and data collection. Thus on the whole three (33%) responses out of a possible nine could be received. Even though energy usage wise these plants represent only 25% of the Integrated Steel Industry in India, they include both the progressive plants, to a certain extent new/modernised and an old plant for which energy management can play a crucial role in sustaining it.

A brief overview of the sector is given below.

Salient features of Indian steel industry

- Installed Capacity 34 MT of finished steel.
- 42 % of finished steel production in Integrated Steel sector.
- 58 % of installed production in Secondary Steel sector.
- SEC ranges from 29.5GJ/tcs to 41.8GJ/tcs.
- Average SEC of Indian industry (33 GJ/tcs) is slowly approaching that of US industry (26 GJ/tcs)
- Most efficient steel making countries are Japan (18 GJ/tcs) and South Korea (19 GJ/tcs)
- Over the years, a number of energy conservation measures taken by each plant.

A sample of the norms that the plants may try to achieve through implementation of their EM policy is presented in Table 8.1b.

Table 8.1b Net Energy Consumption in various technologies

	Net Purchased Energy Consumption/tls						
	Coal kg	Carbon kg	Gas MJ	Oil MJ	Electricity kWh	Tar/Ben MJ	Total GJ
Conventional							
1 EcoTech[1]	380	7	895	832	180	(429)	14.9
2 AllTech[2]	393	6	873	0	54	(348)	13.2
New Technologies							
1 COREX	596	12	1148	0	(567)	0	14.8
New Technologies (DRI)							
1 Midrex	0	17	8890	0	750	0	16.3

(Adopted from Table 3, pp 258, Energy Use in the Steel Industry, IISI 1998)

[1] EcoTech: include all financially viable and proven energy saving technology

[2] AllTech: include all proven technologies regardless of payback

8.2 Analysis of Part A (Quantitative details) of questionnaire

The analysis given below has been derived from the questionnaire survey as well as the published data of the plants. A summary of data collected from different plants is given at Annexure 8.1.

The analysis of the questionnaires revealed the energy expenditure (cost of energy as a percentage of total cost of manufacturing) to range between roughly 25 to 31 %. In the U.S steel industry the energy expenditure comes out to be only 15% which is much lower than the figure for an Indian plant employing similar process (more than 50% of the US steel industry uses recycling through electric furnaces).

On an average the data did not reveal much difference in SEC based on vintage. This may however be due to a mix of technologies working in some plants (typically a part of old facilities continue to function even as another part is modernised). The main factors influencing energy consumption are as follows:

8.2.1 Installed Capacity and Capacity Utilisation

The integrated Iron and Steel industry in India has a total installed capacity of 19.5 MT of crude steel. However the production from these plants totals 16.5 MT for the year 1999-2000 (Table 8.2.1). Thus we can see that there is unutilised capacity in the Integrated Steel Industry. This trend however is an extension of the worldwide trend. The unutilised capacity has a bearing on the energy efficiency and as the table indicates, is correlated to the energy-efficiency. The coefficient of correlation was found to be -0.85.

Table 8.2.1 Capacity utilization and respective specific energy consumption

	Unit	% Capacity Utilization	SEC (GJ/tcs)
1	RSP-SAIL	62.6	41.77
2	IISCO-SAIL	76.8	39.71
3	BSL-SAIL	76.9	33.96
4	DSP-SAIL	83.2	31.39
5	VSP-RINL	88.8	33.22
6	BSP-SAIL	95.4	29.49
7	TISCO	97.0	32.57
		Coefficient of Correlation = -0.845	

Thus one important part of the respective energy management policies of the plants should be to ensure full utilisation of capacities.

8.2.2 Energy from waste

As made apparent in the above analysis the utilisation factors are inversely correlated to the SECs. However an important off-lier in the above analysis is the JSPL plant which is mostly dependent on the Scrap/DRI-EAF route for steel making. Even though the utilisation factor for the plant is only 66%, the SEC is only 26 GJ/tcs implying that the use of new routes of steel making with optimal capacities could be used to harness energy for better purposes. The plant uses the DRI off-gases for electricity production.

8.2.3 Technological Status

Major technological improvements in production facilities have been made in many of the integrated steel plants. The effect of technological improvements is manifested best in the low SEC for the Durgapur Steel Plant (DSP) which has been able to bring down the energy consumption in a short duration. Thus technological improvements in the production facilities can have far reaching consequences as far as the energy consumption scenario is concerned.

8.2.4 Fuel Usage

An encouraging trend of declining energy consumption is evident in the Integrated Steel sector. The figure 8.2.4 gives the coking coal and limestone consumption per tonne of ore processed in various plants. The decreasing trends of coking coal usage per tonne of ore processed indicates better resource

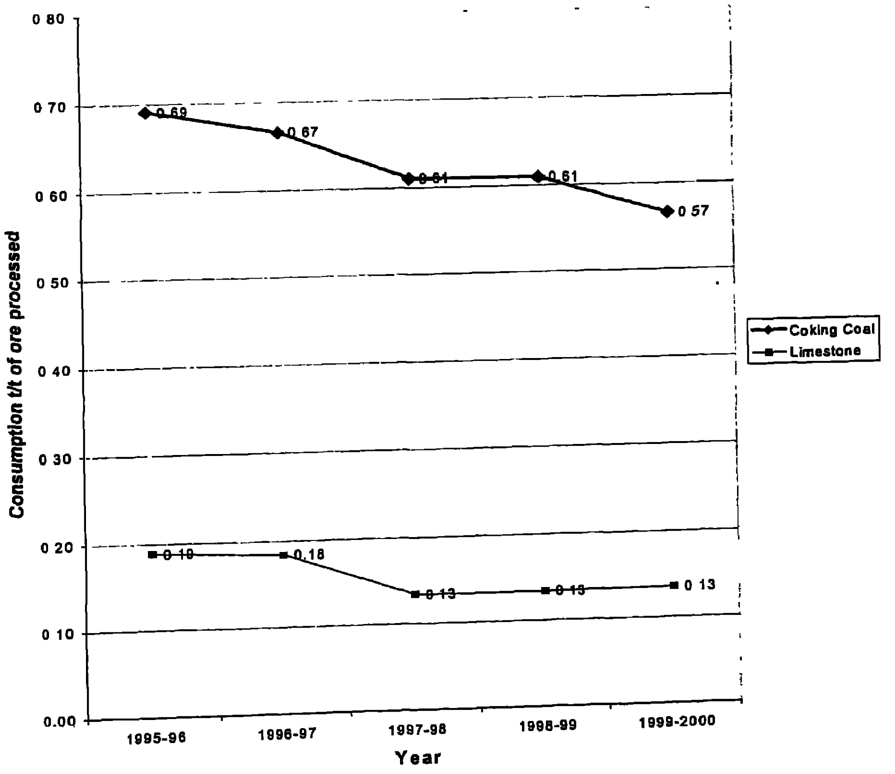


Figure 8.2.4 Resource efficiency over years

efficiency for the steel industry as a whole. The same is evident from the trends for limestone consumption per tonne of ore processed.

A similar trend is also visible in the gaseous and liquid fuel consumption for the integrated steel plants. During the plant visits it was evident that some of the plants are moving towards the zero Petro-fuel category as well.

Even though there has been a trend of enhanced energy-efficiency and resource-efficiency in the India Steel sector, the best is yet to be achieved. Comparison on Japanese steel industry figures with the Indian data is given in table 8.2.4a to facilitate analysis. The figures for India are of one integrated steel plant which for many years has been on the forefront of energy-conservation and energy management activities.

Table 8.2.4a Main Energy Index in Japanese Plants (1998) compared with India (2000)

Item		Dimension	Japan		India
			Best	Average	one plant**
Coke over gas		Nm^3/t	334.6	303.9	683
S.P	Ignition furnace	MCal/t	4	12.0	65.6
	Steam recovery	kg/t	127	63.4	
Fuel ratio of BF	CR	kg/t	487(max)	382	534
Blast furnace gas		Nm3/t	1825	1632	1704
Energy Consumption of Furnaces	Furnace of hot mill	Nm3/t	238	261	376*
	Furnace of plate mill	Nm3/t	174	254	655*
	Furnace of structural	Nm3/t	344	367	646*
	Furnace of bar mill	Nm3/t	218	276	595*
	Furnace of wire mill	Nm3/t	238	271	457*

Steam in process does not include the domestic power station.
*Total heat input including furnace and rolling
** integrated steel plant

In comparison with the international standards for energy-efficiency, the Indian Steel sector does not stand out very well. Table 8.2.4b gives a comparison of the SEC figures for the major steel producing countries.

Table 8.2.4 b Comparison of SEC figures for major steel producing countries

Country	India	Japan	U.S.A.	China	Germany	South Korea
SEC (GJ/tcs)*	33	18	26	38	20	19

* 1995 figures for all countries except India for which 1999-2000 figures are given

8.2.5 *Major Energy Saving Measures*

The major energy saving measures that the plants have enumerated in the questionnaire survey are given in Table 8.2.5.

Table 8.2.5 Major energy saving measures

Sl.No.	Major Energy Saving Measures	Investment (Rs. lakhs)
1a	Overhauling of BF gas holder	80
1b	Recommissioning of Gas Mixing Stations at Rolling Mills Complex	15
1c	Thermal insulation of bare heating surfaces of boiler & HP steam lines	6.6
1d	Arresting steam leakages using online/conventional methods and by installation/replacement of steam traps and valves	3.5
1e	Installation of capacitor banks at Oxygen plant	10
1f	Introduction of BF gas firing in Boilers	400
2a	Steam enhancement by providing extra heat in waste heat recovery boiler	27
2b	Change of submerged arc furnace design from close to open type & improvement of charge distribution	43
2c	SMS modification for long sequence casting	50
2d	Use of washery rejects and chars in place of coal in boiler	–
2e	Use of centrifuge to remove moisture from washed coal instead of oil fired boiler	20
3a	Commissioning of stamp charging battery	19550
3b	Improvement in combustion system of ignition furnaces at Sinter plant	1080
3c	Centralised compressed air system	398
3d	Top gas analysers for blast furnaces	70
3e	Enhanced LD gas recovery	86
3f	Installation of Ammonia incinerator with waste heat recovery	1075
3g	Installation of gas fired boilers and co-generation of power in Boilers	12000

8.3 Analysis of Part B (Energy management practices)

This section is based on the analysis of the responses received from the plants.

8.3.1 Energy/Environment/Quality Policy

There was no Energy Management Policy for any of the plants. However two of the plants had such policies under formulation (Annexure 8.2). All the three plants that responded had the Quality Policy as well as the Environment Policy in place. The policies are publicly displayed indicating that there is a concern about these issues.

8.3.2 Commitment for Energy Management

As per the responses received EM is the critical focus of the top management. In one case it was observed that there is no separate organisation within the plant to implement energy management.

8.3.3 Energy Management Cell, its Organisation and Role

The three plants, which made available the data in response to the questionnaire, had different approaches to energy management. In the first instance the energy management organisation had responsibilities both for energy generation (power plant) as well as monitoring etc. In the second instance the functions were limited to monitoring and small projects while in the third instance there was no such formal organisation and activities were implemented through a group of people drawn from different departments.

8.3.4 Small Group Activities

Small group activities were undertaken in all the responding plants and were found to be successful. They usually involved the shop floor people and the junior management. Regular reporting of EM data was done in all the places but the frequency differed. There was a marked correlation between the success of plants on the EM front and the frequency of meetings as well as the formalised structure of the EM cell.

8.3.5 Role of Energy Audit

Though energy audits were carried out in plants; they were not very regular in those plants that did not have a good performance on the energy front or at least a decreasing trend in energy consumption per unit of output. The same trend was also evident vis-à-vis the regular training activities and the budget allocation for the same.

8.3.6 Energy Conservation Budget

A tendency to keep to the top management the decisions regarding the energy management activities was evident, however, this may also be related to the scale of operations.

8.3.7 Interaction with other Industries and associations

The plants view interaction with the peer industry as a very important source of information and valued the information provided through the associations through seminars and other activities.

8.3.8 Barriers for Energy Conservation

It was found across the board that the plants found the cost of technology, the cost of servicing the finances as well as the cost of expertise to be the major barriers that were preventing the promotion of energy management activities. Government policies in this regard were viewed mostly with optimism except for one case where apart from fiscal benefits like reduction in customs and excise duties and equipment subsidies, lower interest rates, R&D support was also asked for. One concrete suggestion that emerged was formulating the consumption norms under the Energy Conservation Act as guidelines to which incentives should be attached for compliance.

8.3.9 Energy Management Policies

The responses indicated that all the plants view the top management's commitment as the most important point followed by regular monitoring and installation of energy efficient equipment (in that order).

8.4 Field visits

Two field visits were undertaken to the Tata Steel Plant at Jamshedpur and JSPL plant at Raigarh

8.4.1 Tata Iron & Steel Company, Jamshedpur

TISCO is the biggest player in the private sector of the Indian Steel Industry. It was the first integrated steel plant in India and has maintained its position of technical leadership in the industry through continuous improvement. Though in terms of specific energy consumption it ranks only second, but it's facilities (especially after major modernisation in the 1990s, and continuing efforts) and functioning, which usually follow the international bests, call for a closer look in order to learn from their experiences in energy management.

The plant has installed capacities of 3.8 million tonnes of pig iron and 3.28 million tonnes of saleable steel. The capacities have been enhanced in the recent years. A major modernisation has been undertaken in the plant and replacements of old and small blast furnaces by bigger and more efficient blast furnaces are in the way. Stamp charging coke oven batteries have also been introduced.

The plant has successfully tapped international funds for the upgradation of technology. Over the last three years the plant has achieved production which is greater than the installed capacity while cutting down on the energy consumption per unit of product. Also through a sustained policy to cut down on petro-fuels, the plant has become a nearly zero petro-fuel plant. The plant has certification for ISO 9002 as well as ISO 14001.

The plant has a formal Quality Policy and an Environment Policy, which are publicly displayed. The process of formalisation of the Energy Management Policy is ongoing and a draft is under circulation.

8.4.1.1 Commitment to Energy Conservation

Discussions brought out that energy issues are a critical focus of the top management. The management participates in the planning and review of the energy management projects on a regular basis and the achievements are highlighted ion the annual reports. While deciding the energy management policies a cross-functional approach is taken and the perspective of different areas as well as different levels is taken into account. Details of energy conservation and research and development activities are published in the Directors' Report.

8.4.1.2 The Energy Management Cell

The plant has a well-defined organisational setup working for energy management, called the "Fuel Management". The Energy Management Centre is a part of this setup. Other areas include Fuel and combustion, steam and power, Statistical, Instrumentation etc. The set up draws upon from the expertise of Electrical, Mechanical and Chemical Engineers who have specialised in Energy Management or Instrumentation. The cell implements energy management through making blue prints of energy management plan, identifying and executing projects and continuous monitoring of energy consumption of plant and equipment. It also provides training for plant personnel and motivates them to save energy through various schemes. The cell also has the responsibility for making reports related to energy management for review at various levels of management and identify the pollution prevention opportunities.

The reporting of energy consumption figures is a regular activity in the plant and reports are made at the levels of section heads, plant head and top management on a daily, weekly and monthly basis. The cell also interacts with the top management at frequent intervals to apprise them of the status of energy management in the plant.

By having an Energy Management Centre which is manned by full time personnel, involvement of top management and annual budgetary commitments the plant ensures the effectiveness of the cell. The decisions on investments are taken care of mostly by the top management but a certain degree of delegation of powers to the section heads exists. The investment decisions are usually made on the basis of a techno-economic analysis where the quantum of savings is given good weightage. The emphasis is on projects which could be executed in house.

An integral part of the energy management organisation in TISCO is the Energy Management Centre, which is equipped with online system to monitor and control energy usage throughout the plant. Since energy systems could also take the form of potential safety hazards in case of emergency the system is also equipped to shut off supplies or isolate such systems. This system is also very crucial in providing information whenever required and speed up identification of losses and opportunities for energy conservation. It is also used extensively in the internal energy audits of the plant.

8.4.1.3 Initiatives to promote Energy Management

The plant carries out a lot of small group activities with relation to energy management. There are a total number of 4880 small groups in the plant and many of these have focus on energy management. There are also 32 active quality circles. The Fuel Management is running 85 projects on energy management along with 52 Quality Improvement Programmes. The small group activities are carried out at the level of the shop-floor workers and the junior management. It also conducts both internal and external energy audits on a monthly basis.

The targets to reduce energy consumption are decided taking into consideration the previous years figures of energy consumption, the best figures in the industry and the international norms.

8.4.1.4 Interaction with Peer Group

Regular visits to other plants are organised and sharing of information and case studies through the associations is also done to improve information base for energy management. The role of the association in regard to organising industry meets and seminars as well as publishing the statistics related to energy management is found to be useful by the plant.

The plant feels that the present policies of the government are conducive for the promotion of the energy management, though barriers mostly exist in the form of high costs of technology and the high prevailing interest rates.

8.4.1.5 Crucial Issues

As per the plant the crucial issues that have to be taken into consideration for the framing a company's energy management policy are the role of the top management towards energy conservation, the existence of a well defined energy management cell equipped with an EMIS. Monitoring and proper targeting of energy consumption figures through regular energy audits and implementing the projects by installation of energy efficient equipment were the other issues that were identified.

8.4.2 Jindal Steel & Power Ltd., Raigarh

JSPL is one of the latest entrants in the Iron & Steel Industry. The plant was commissioned in the year 1991. It is the biggest coal based sponge iron plant in India. The plant has both ISO 9002 and ISO 14001 certification. It also has formal Quality policy and Environment Policy while the Energy Management Policy is under formulation. The policies are displayed publicly. The Energy Management Policy is under formulation.

The plant has installed capacities of 6,50,000 tonnes of sponge iron, 4,00,000 tonnes of steel and 30,000 tonnes of Ferro-chrome. The steel capacity was added in the year 2000-2001. A major modernisation drive is ongoing in the plant, and additions of mini blast furnace to feed hot metal to the electric furnaces for steel making and a rail mill for value addition in the downstream products are in the way. The plant also has 97.5 MW of power production capacity and a new 55 MW capacity addition is underway. The power facilities also generate substantial revenues. The process flow sheet for this plant is given in Annexure 8.3.

8.4.2.1 Commitment to Energy Management

Energy Management is an important focus of the top management and the top management regularly participates in planning and review of various energy management project. The top management also involves the managers from different departments in formulation of the energy management policy. The Directors' report also carry mention of the policy and implementation of various energy management projects. There is no board member who has the specific responsibility for energy management but the overall business plan of the management takes into account the energy management plan.

8.4.2.2 The Energy Management Cell

Even though the top management has a focus on energy management, the related activities are not implemented through any separate organisation within the company. Senior managers from different departments have been given additional responsibilities of energy management and there are regular meetings where the discussions are held. On a weekly basis the data is also reported to the level of the plant head. The department heads regularly meet the top management under the overall business plan and energy consumption figures as well as the plans are discussed.

8.4.2.3 Initiatives to promote Energy Management

The plant organises a number of small group activities, which among other areas also work on energy management. These small groups usually involve the shop-floor workers and the junior managers. Sometimes the middle managers also attend. The groups meet regularly at weekly intervals. Energy audits are usually held after two years by external firms.

Requirements of budget for energy management activities are usually decided by the top management keeping in mind the quantum of savings and the possibilities of implementing the project in-house.

The targets for energy consumption figures are set on the basis of the previous year performance. There is no separate yearly training budget for the training of personnel and training are held as and when required. Staff is motivated by highlighting the energy management achievements in the internal newsletters. The plant follows the concept of Green Productivity, a highlight of which is given in the Box below.

Green Productivity and Eco-Club at JSPL

The plant has adopted the Japanese concept of Green Productivity, which is a concerted effort to stop pollution at source and convert waste into wealth. The plant also participates in the GP programme initiated by the MP-PCB and has many small group activities going on with regard to this along with a GP competition between the departments.

8.4.2.4 Interaction with Peer Group

JSPL has granted access to the peer industries to the technical information it has and also gains from visits of its employees to other such plant. The plant was of the view that the associations should also provide information about energy management opportunities to the plants.

Though JSPL finds the government policies in regard to energy management quite satisfactory it suggests that the provisions in the energy conservation bill regarding norms for processes or consumption standards should be in the form of guidelines to the industries and compliance should be rewarded through rewards or equipment subsidies. The high cost of equipment and expertise are also viewed by the plant as major barriers in implementation of energy conservation measures.

8.4.2.5 Crucial Issues

The crucial issues (in order of priority) in view of the plants, which have to be kept in mind while formulating the guidelines are

1. Role of top management and its commitment towards energy conservation
2. Monitoring and targeting
3. Regular energy audits to identify energy management opportunities
4. Installation of energy efficient equipment
5. Strategy for re-design and retrofitting
6. Role of EMIS

8.5 Issues to be stressed while framing the energy policies of the Steel industry

8.5.1 Top Management Commitment

It is very important for the shop-floor worker to see the commitment of the top-management to EM. Demonstration of the top managements' participation and encouragement are very important. The CEO could make this visible through the EM policy statement and regular review of energy conservation projects. This will ensure employee participation, which is probably the most important tool for Energy management.

The commitment of the top management to EM can be in terms of a self set target which would spell the activities on the shop floor to achieve this target. It has been observed that in Japan, industries set energy reduction targets on their own and meet them in almost all cases.

8.5.2 Reinforcement of organisation

In order to bring about energy savings it is extremely important that an Energy Management Cell be created within the individual companies. Some Indian steel companies already have such a cell while many others have some other group carrying out similar activities. But the current inefficiencies in the industry indicate that there is a lot of potential that is still not realized. Both these types of systems need to perform better so that further energy saving could be achieved, and in order to do so there is need for reinforcement of such a cell. This can be achieved by way of having a proper structure for the energy management cell and enhancing the effectiveness of its interaction with the manufacturing divisions of the company.

It was observed that the Indian concept of EM cell is different from the EM cell in Japan inasmuch as the power utilities (operation) does not form a part of it. Thus the Indian steel plant EM cell would not be responsible for producing energy but only for its conservation. The Japanese model is observed to be working in at least one plant with a great degree of success. Such a structure could easily be emulated in India. The structure is given in Figure 8.5.2.

The Cell should be able to interact with the manufacturing divisions and others divisions that can be the Power & Utilities (in case of the prevailing structures of the EM cell) or any other like the Blast Furnace or the Steel Melting Shops, in a way that is symbiotic in nature. Each shop should be able to identify a key person in a responsible position who would look after the EM needs of the manufacturing shop. He should be working in tandem with the EM cell and should ensure that the other key operation personnel have a grasp of energy usage figures and issues.

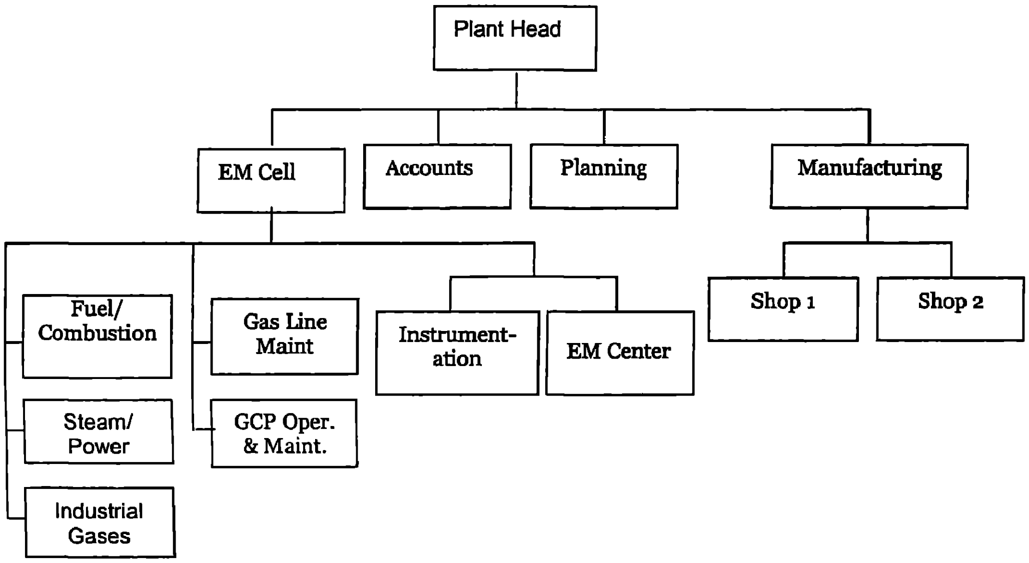


Figure 8.5.2 Suggested structure for EM Organisation Energy Management Cell

Also the EM cell should have working links with the accounting and the maintenance divisions which are important insofar as the energy wastage prevention and control and accounting of its financial impact are concerned. This close working will also bring to fore the energy issues in the minds of the personnel the energy management/conservation issues & their financial implications and this will influence their decision making.

Definition of roles

It would be important to chalk out the roles of the EM cell and that of other divisions/sub-divisions in the present context. A sample of the responsibilities of an Energy Manager are given in Box below.

Responsibilities of an Energy Manager*

- Oversee the formulation and implementation of an energy policy.
- Introduce systems to provide management information about energy consumption.
- Report appropriate energy consumption information to accountable staff and senior managers.
- Develop policies and procedures for the purchase of fuels and assist with contract negotiations.
- Raise and maintain energy awareness throughout the organisation.
- Introduce and maintain effective good housekeeping and plant operating procedures.
- Identify training needs for energy-related skills and understanding.
- Identify opportunities for increasing energy efficiency.
- Formulate an investment programme for reducing energy consumption.
- Introduce and maintain procedures for evaluating energy management projects and monitoring subsequent savings.

* Energy-wise Practice-3 Energy Efficiency & Conservation Authority, New Zealand

8.5.3 Energy conservation policy

The company should enunciate a clear-cut policy that will be a guide to company personnel involved directly or indirectly in efforts to reduce energy consumption in the plant. Such a policy would have a long-term perspective with the activities for the medium term and short term being derived from it.

The importance of the long-term perspective can be judged from the experience of Sumitomo Metals whose energy saving campaigns ran over several years evolving with the needs of the time.

Thus the Indian steel-making companies should endeavour to have longer-term campaigns with targets set for many years; broken up into achievable smaller parts. They could centre on reducing energy consumption or cost or even prevention of pollution through a cut in energy consumption. This should normally not be difficult as most of the steel making companies have energy and environmental cells working in close tandem. Fuel switching (especially reduction of petro-fuel consumption wherever feasible) should also be an important consideration.

The importance of the cost reduction aspect of the energy management/ conservation should be emphasized because of its effect on the bottom-line which is the prime accepted motive for business as well as the main determinant of the companies long term financial viability.

While in the immediate future it may be difficult if not impossible for the best Indian companies to achieve the world average figures for energy consumption but a carefully planned out roadmap leading to this ultimate objective should be able to guide the plants to a better energy efficiency.

8.5.4 Roadmap for energy efficiency

It will be important here, to work out the inefficiencies related to the poor quality of raw material, especially coal. Taking these into consideration as well as the current level of performance a roadmap should be chalked out which will define how the company intends to reduce its energy consumption over the years. Additionally environmental concerns can also be built into the roadmap.

This roadmap will be different from the long term campaign talked about earlier in that the road map would be broader and longer term document and it could be used to derive the long term campaign which is still further broken down to get the annual energy saving targets.

8.5.5 Means for energy conservation

The core of the energy management lies in having the infrastructure, the motivation and the means for actual energy saving activities. The first step is to grasp the actual energy statistics and then to act upon those. The activities could range from motivating the workers to save energy through education campaigns, small group and project team activities, and development of projects and technologies, their budgeting and evaluations of the same.

First of all an energy accounting system should be in place, and vital data be conveyed to and discussed among the top managers of the company. An EMIS system or its like could be used for energy accounting. The system set up in one of the steel plants had online information related to energy flowing in from all the parts of the plant and by continuous monitoring it was possible to advice the truant shop or system to control the activity. The important aspects of energy monitoring and targeting system are given in the Box below.

The EM cell teams should along-with the manufacturing shop people, carry out daily weekly and monthly checks of the various high energy consuming equipment of the shops and should be able to fix them through the help of the maintenance teams. A record-keeping system should also be in place, which will help in analysis of the equipment performance, and the necessary information should be brought out in the meetings with the higher management.

Regular meetings of the top personnel of the EM cell should be held to take cognisance of the energy consumption figures and take decisions to alleviate the problems.

Aspect of Energy Monitoring and Targeting System

Recording - Measuring and recording energy consumption

Analysing - Correlating energy consumption to a measured output, such as floor area, outside air temperature or production quantity

Comparing - Comparing energy consumption to an appropriate standard or Benchmark

Setting Targets - Setting targets to reduce or control energy consumption

Monitoring - Comparing energy consumption to the set target on a regular basis

Reporting - Reporting the results including any variances from the targets which have been set

Controlling - Implementing management measures to correct any variances Which may have occurred.

8.5.6 Budget for investment

In order to implement energy saving technologies rational budgeting support is a must. This should be made possible under the guiding policies of the company on investment and should be evaluated thoroughly on its energy-conservation and economic aspects.

A detailed evaluation system of the energy conservation/management plans should be worked out in order to comprehensively analyse the benefits and costs to the company. The benefits should be calculated in terms of energy savings, savings in energy costs and long-term use and viability of the project.

Evaluation should also take into account the 'invisibles' such as safety, improved environment, improved quality and reduced maintenance.

8.5.7 Energy saving promotion activities

Energy resources find such varied use in plants that it is important that energy management and conservation activities be taken up at all levels starting from the lowest. Thus small group activities, project team activities and technology development all form important parts of the energy saving promotion.

Small group activities that are organized among the workers and foremen to educate the workers about the contribution they can make to make their plant more energy efficient.

8.5.7.1 Project team

Technological improvements can be brought about through in-house resources of the plants in India as the plant are usually equipped with sufficient trained manpower to design develop and implement energy conservation projects.
Project team activities have proved to be very valuable contributors to energy efficiency in the Japanese context and through modification to suit the Indian conditions, namely the extent of the hierarchy involved, should prove to be very beneficial. Waste heat recovery and design optimisations are the main activities that would fall within the purview of these groups.

A culture of energy consciousness is very important to build the edifice of better energy efficiency. Small daily activities should like putting off lights when leaving workplace and other such small things would not only save energy but also reinforce the culture of energy conservation. Employee education and motivation are in this regard, important inputs.

8.5.8 Development of energy saving technology

Another important part of the development of energy savings is the in-house development of energy saving technology or adoption of such a technology to suit Indian conditions. In general, companies which conduct in-house research and development spend a very small part of turnover on such activities. Such activities need to be taken up at a larger scale.

In order to develop in-hose the technologies for energy conservation, regular interaction between the EM cell, manufacturing shops and the R&D division should take place. In hose design and development has the benefit of being tailor made for the plants' specific conditions while being available at a lower cost. The energy management policy should lay down the path for a process through which the design & development activities talked about in the previous section could be effectuated. This should evolve around the needs of the plant as enunciated by the manufacturing shop/EM cell, and it's solution provided by the R&D team.

8.5.9 Audits

Energy audits are effective in crosschecking the energy statistics and also bring to the companies' external knowledge on energy conservation technologies. Audits can also be a way to determine the possibilities of process optimisation.

Daily inspections should be carried out in accordance with the standards set for the facility through various rules and standards that may be available and deviations marked. Then trouble-shooting exercises can take place.

Internal audits are a very important exercise which at first are a self-assessment which help the plant to take note of it's own inefficiency and set the fault right. There should be set guidelines for the audits that will be helpful in comparison of data of different audits. External audit is a cross-checking exercise which is a must as it not only provides the above help but also brings in external learning in the form of advice and recommendations. The mandatory energy audits that have come into force in some states can prove to be fruitful exercises to this effect.

8.6 Conclusions

As the current state of technology in the Indian steel industry is low and in most cases, the potential for energy conservation is large. The technology driven solutions could be expected to give good results. But on the other hand a closer analysis revealed that a lot of savings are also possible by implementing small projects especially those of waste heat utilisation and process optimisation. Education and motivation of employees and their involvement in the project group activities would be greatly benefiting the energy conservation and management activities. These are to be implemented mainly through the small group activities.

Prioritising the actions that have to be taken to initiate an effective energy management campaign, the activities would be

1. Organising the Energy Management Cell headed by a competent person.
2. Exploring opportunities and planning for investment.
3. Enhancing operational improvements.

However, the priorities may change from plant to plant depending on the current level of activity that has already been undertaken in that plant.

Annexure 8.1

Summary of the data collected from plants

Plant A

Sl. No.	Description	Units	Year 1998-99	Year 1999-00	Year 2000-01
1	Products				
	Saleable Steel				
	Installed Capacity	Tonnes	2700000	3280000	3280000
	Actual Production	Tonnes	3109530	3286732	3487283
2	Specific Energy Consumption				
	Thermal SEC	GJ/tcs	33.48	32.57	30.99
3	Energy Consumption and Cost				
	Electrical Energy	MWH	1527063	1579679	1607257
	Cost	Rs. lakh	26389.5	27848.3	30762.4
	Coking Coal	tonnes	2998083	3218472	3336695
	Cost	Rs. lakh	60397.88	59090.50	61867.00
4	Energy Conservation Measures		Investment (Rs. lakh)	Savings (Rs. lakh)	
a	Commissioning of stamp charging battery		19550		
b	Improvement in combustion system of ignition furnaces at Sinter plant		1080		
c	Centralised compressed air system		398		
d	Top gas analysers for blast furnaces		70		
e	Enhanced LD gas recovery		86		
f	Installation of Ammonia incinerator with waste heat recovery		1075		
g	Installation of gas fired boilers and co-generation of power in Boilers		12000		
5	Organisational Structure of the EM cell				
	EM Cell	Yes			
	Energy Manager	Yes			

Sl. No.	Description	Units	Year 1998-99	Year 1999-00	Year 2000-01
	Energy Audit	Yes			
	Energy Management Policy	Draft			
	Environment Policy	Yes			
	Quality Policy	Yes			

Plant B

Sl. No.	Description	Units	1998-99	1999-00	2000-01
1	Products				
	Ingot Steel				
	Installed Capacity	tonnes	1000000	1000000	1000000
	Actual Production	tonnes	301023	290331	328429
2	Specific Energy Consumption				
	Thermal SEC	GJ/tcs	45.45	43.96	40.32
3	Energy Consumption and Cost				
	Electrical Energy	MWH	222987	213887	225969
	Cost	Rs. lakh	6531	6217	6986
	Coking Coal	Tonnes	1099200	1168722	1040865
	Cost	Rs. lakh	2071.14	1172.68	1420.76
4	Energy Conservation Measures		Investment	Savings	
A	Overhauling of BF gas holder		80		
B	Recommissioning of Gas Mixing Stations at Rolling Mills Complex		15		
C	Thermal insulation of bare heating surfaces of boiler & HP steam lines		6.6		
D	Arresting steam leakages using online /conventional methods and by installation /replacement of steam traps and valves		3.5		
E	Installation of capacitor banks at Oxygen plant		10		
F	Introduction of BF gas firing in Boilers		400		
5	Organisational Structure of the EM cell				

Sl. No.	Description	Units	1998-99	1999-00	2000-01
	EM Cell	Yes			
	Energy Manager	Yes			
	Energy Audit	Yes			
	Energy Management Policy	No			
	Environment Policy	Yes			
	Quality Policy	Yes			

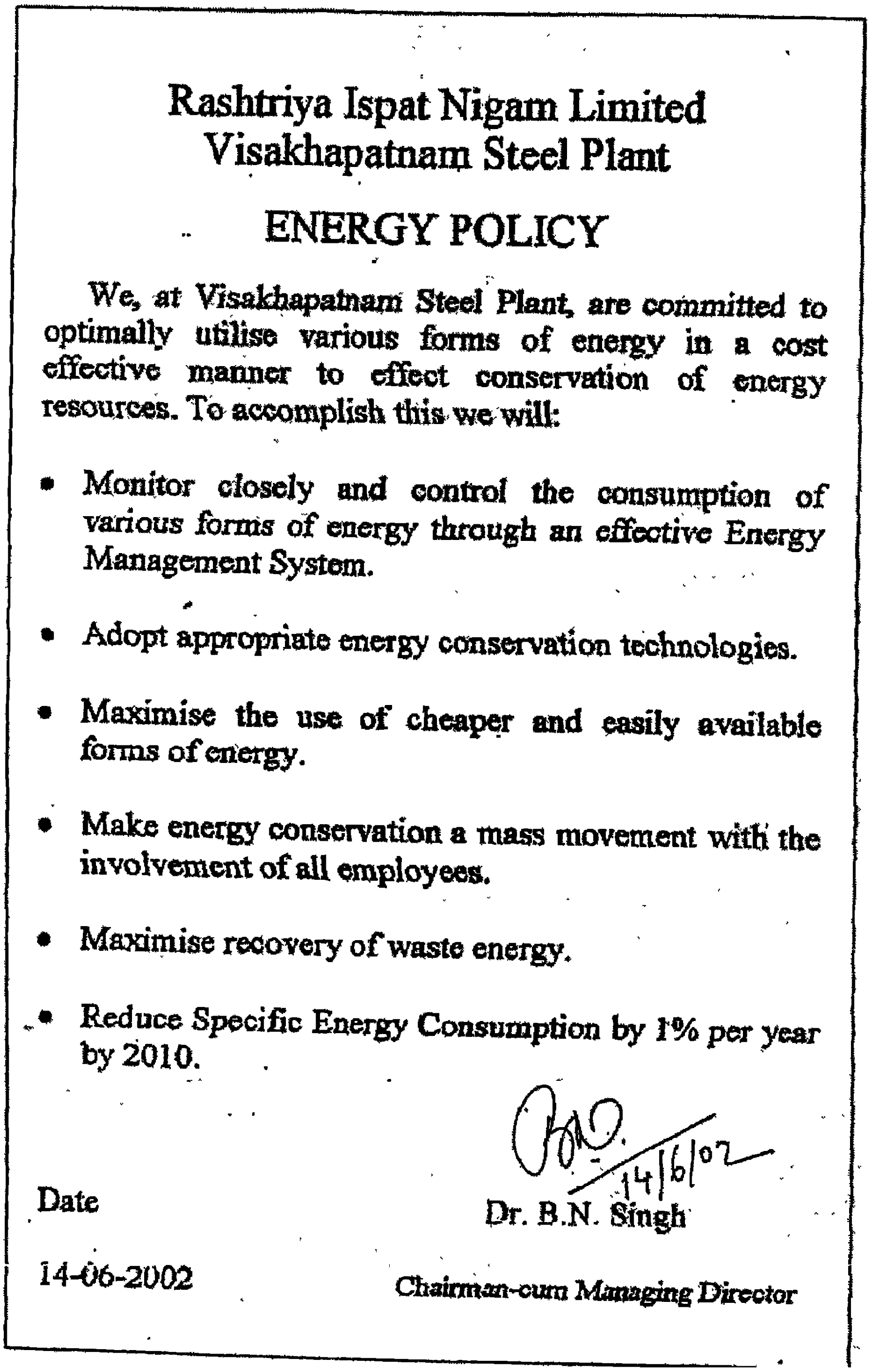
Plant C

Sl. No.	***Description***	***Units***	***1998-99***	***1999-00***	***2000-01***
1	*Sponge Iron*				
	Installed Capacity	*tonne*	*500000*	*500000*	*575000*
	Actual Production	*tonne*	*400469*	*417749*	*502614*
	Steel				
	Installed Capacity	*tonne*	__	__	*400000*
	Actual Production	*tonne*	__	__	*109028*
2	***Specific Energy Consumption***				
	Sponge Iron				
	Electrical SEC	*KWh/t*	*78.71*	*75.95*	*76.34*
	Thermal SEC	*GJ/t*	*6.07*	*6.35*	*6.23*
	Steel				
	Electrical SEC	*KWh/t*	__	__	*1152.9*
	Thermal SEC	*GJ/t*	__	__	__
3	***Energy Consumption and Cost***				
	Electrical	*MWH*	*4922*	*11278*	*24861*
	Coal	*tonnes*	*653699*	*529129*	*1115524*
	Cost	*Rs. lakh*	*6115.5*	*2273.0*	*4123.1*

Sl. No.	***Description***	***Units***	***1998-99***	***1999-00***	***2000-01***
4	***Energy Conservation Measures***		***Investment***	***Savings***	
A	*Steam enhancement by providing extra heat in waste heat recovery boiler*		*27*		
B	*Change of submerged arc furnace design from close to open type & improvement of charge distribution*		*43*		
C	*SMS modification for long sequence casting*		*50*		
D	*Use of washery rejects and chars in place of coal in boiler*		*--*		
E	*Use of centrifuge to remove moisture from washed coal instead of oil fired boiler*		*20*		
5	***Organizational Structure of the EM cell***				
	EM Cell	*No*			
	Energy Manager	*No*			
	Energy Audit	*Yes*			
	Energy Management Policy	*No*			
	Environment Policy	*Yes*			
	Quality Policy	*Yes*			

Annexure 8.2

Energy policies



Rashtriya Ispat Nigam Limited
Visakhapatnam Steel Plant

ENERGY POLICY

We, at Visakhapatnam Steel Plant, are committed to optimally utilise various forms of energy in a cost effective manner to effect conservation of energy resources. To accomplish this we will:

- Monitor closely and control the consumption of various forms of energy through an effective Energy Management System.
- Adopt appropriate energy conservation technologies.
- Maximise the use of cheaper and easily available forms of energy.
- Make energy conservation a mass movement with the involvement of all employees.
- Maximise recovery of waste energy.
- Reduce Specific Energy Consumption by 1% per year by 2010.

14/6/02

Date

14-06-2002

Dr. B.N. Singh

Chairman-cum Managing Director

DRAFT

THE TATA IRON AND STEEL COMPANY LTD.

ENERGY POLICY

Tata Steel reaffirms its commitment to conserve scarce energy resources and shall endeavour to: -

- ➢ Comply with national and international regulations
- ➢ Adopt best available technology for energy efficiency
- ➢ Implement world class operating practices
- ➢ Conduct regular Energy Audit for continual improvement
- ➢ Promote energy efficiency through mass awareness

(B.Muthuraman)
Managing Director

Annexure 8.3

Process flow sheet for Jindal Steel & Power Ltd, Raigarh

JINDAL STEEL AND POWER LIMITED, RAIGARH

8.	**Please attach on the next sheet a simple schematic diagram production process of the entire unit.**

THE PLANT PROCESS FLOW